



**पंडित रविशंकर शुक्ल विश्वविद्यालय, रायपुर छत्तीसगढ़ भारत**  
**Pt. Ravishankar Shukla University, Raipur Chhattisgarh, India**  
Estd-1964 – recognized by UGC U/s 2(f) and 12 (B)  
**NAAC “A” Grade**

## Syllabus 2020-21

S. No.	Department	Pg. No.
1	School of Studies in Ancient Indian History Culture & Tourism & Hotel Management	1-44
2	School of Studies in Anthropology	45-127
3	School of Studies in Biotechnology	128-182
4	School of Studies in Chemistry	183-238
5	Swami Vivekanand Memorial School of Studies in Comparative Religion, Philosophy and Yoga	239-262
6	School of Studies in Computer Science & IT	263-333
7	School of Studies in Economics	334-362
8	School of Studies in Environmental Science	363-394
9	School of Studies in Electronics and Photonics	395-511
10	School of Studies in Geography	512-516
11	School of Studies in Geology and WRM	517-563
12	School of Studies in History	564-654
13	School of Studies in Law	655-809
14	School of Studies in Library & Information Science	810-837
15	School of Studies in Life Science	838-939
16	School of Studies in Literature and Languages	940-1098
17	Institute of Management	1099-1128
18	School of Studies in Mathematics	1129-1184
19	University Institute of Pharmacy	1185-1252
20	School of Studies in Physical Education	1253-1371
21	School of Studies in Physics and Astrophysics	1372-1415
22	School of Studies in Psychology	1416-1531
23	School of Regional Studies and Research	1532-1594
24	School of Studies in Sociology & Social work	1595-1681
25	School of Studies in Statistics	1682-1685
26	Institute of Teacher Education	1686-1824
27	Centre for Women's Studies	1825-1841
28	Renewable Energy Technology & Management	1842-1938
29	Centre for Basic Sciences	1939-2144

**SCHOOL OF STUDIES IN STATISTICS, PT. R.S.U., Raipur**

**Syllabus**

**M.A./M.Sc.- Choice Based Credit System, 2021-22**

**Subject: Statistics**

**Scheme of Examination**

<b>Semester</b>	<b>Paper</b>	<b>Subject</b>	<b>Total Marks</b>	<b>Total Credits</b>
<b>Semester II</b>	<b>I</b>	Basic Statistics-I	100	03
<b>Semester III</b>	<b>I</b>	Basic Statistics-II	<b>100</b>	<b>03</b>

**M.A./M.Sc. II Semester: Choice Based Credit System**

**Subject: Statistics**

**Paper- I**

**BASIC STATISTICS-I**

**Unit-I**

Methods of Data Collection, types of data, construction of questionnaire, Processing and analysis of data. Presentation of data. Measure of central tendency and dispersion. Karl Pearson's coefficient of correlation, Rank correlation. Lines of Regression.

**Unit-II**

Mathematical and statistical definitions of probability. Idea of Probability distribution. Normal distribution. Test of Hypothesis, level of significance, p –value, Applications of chi square, t and F distribution. Chi square test for goodness of fit.

**Unit-III**

Sampling techniques: Simple random sampling, Stratified random sampling, Cluster Sampling, Systematic sampling, non sampling error.

**Unit-IV**

One way and two way analysis of variance, Use of Statistical Software packages for data analysis – SPSS and Excel.

**References:**

1. Goon A.M., Gupta M.K., Dass Gupta B. (1991): Fundamentals of statistics, Vol.I & II, World Press, Calcutta.
2. Gupta V. K. and Kapoor S. C.(2005): Fundamentals of Mathematical Statistics S. Chand and Sons.
3. Mood A. M. Graybill F.A. and Boes D.C. (1974): Introduction to the Theory of Statistics, MegrawHill.
4. Bhatt B. R., Srivenkatramana T and Rao Madhava K.S. (1977): Statistics : A Beginner's text, Vol.II, New Age International (P) Ltd.
5. C.R.Kothari,"Research Methodology", Second Edition, Wishwa Publication, New Delhi.
6. Shukla S. M. & Sahay S. P. (): Business Statistics, Sahitya Bhawan Publications, Agra.



**M.A./M.Sc. III Semester: Choice Based Credit System**  
**Subject: Statistics**  
**Paper- I**  
**BASIC STATISTICS-II**

**UNIT-I**

Sources of demographic data –census, register, adhoc survey, hospital records, measurement of mortality, crude death rate, age specific death rates, standardized death rate infant mortality rates, Complete life table and its applications. Laws of mortality and Makeham's law.

**UNIT-II**

Measurement of fertility-crude birth rate, general fertility rate ,age-specific birth rate, total fertility rate, gross reproduction rate. The Stable and Stationary populations, Logistic curve for population growth, Population Projection.

**Unit III**

Different Component of time series, Measurement of secular trend: Fitting of trend, method of moving average, effect of elimination of trend, Yule-Slusty effect, merits and demerits of different methods of trend estimation. seasonal components and its estimation.

**Unit IV**

Index number :meaning and construction of index number, different formulae for constructing index numbers, Laysperes and Paasche's index number, tests of a good index number, Fisher's Ideal index number. Chain base index numbers, Cost of living index numbers, Whole sale price index numbers. Demand Analysis: Demand and supply curves, Price elasticity of demand and supply, Engel' Law.

**References:**

1. O. S. Srivastava (1983) – A text book of demography ,Vikas Publishing House.
2. Parimal Mukhopadhaya (1999) – Applied Statistics, Books and Allied (P) Ltd.
3. V. K. Kapoor and S. C. Gupta: Applied Statistics, Sultan Chand and Sons.

**PT. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR**  
**SCHOOL OF STUDIES IN STATISTICS**

**Syllabus for Ph. D. Course Work in Statistics, 2016-17**

The Ph.D. Course in Statistics shall be of six months.. This course shall have two papers.. Paper I is theory paper and Paper II is project course work. Each paper is of 100 marks .Theory paper will be of 3 hours duration. In paper II, 40% marks will be assigned to seminar which will be evaluated by departmental research committee and 60% marks will be assigned to project work which will be evaluated by external and internal examiner jointly.

<b>Scheme of Examination</b>	
Paper I : <b>Research Methodology , Quantitative Methods &amp; Computer Applications</b>	<b>:100 Marks</b>
Paper II : <b>Review of Literature concerning the topic of research and Seminar/Project report</b>  <b>(a) Seminar</b> <b>(b) Project work and Viva Voce</b>	<b>:100 Marks</b>  40 marks 60 marks
Total Marks	<b>200 Marks</b>

**Paper I**

**Research Methodology, Quantitative Methods & Computer applications.**

**Unit I:** Research methodology: An introduction, meaning of research ,objective of research, Research Methods versus Methodology, Selection of research problem, Necessity of defining the problem. Technique involved in Defining a problem. Methods of Data Collection: Collection of Primary data, construction of questionnaire, Collection of data through questionnaire, Difference between questionnaires and schedules, Some other methods of data collections, Collection of Secondary data, Processing and analysis of data. Use of Statistical package, SPSS for data analysis.

**Unit II:** A review of Simple Random Sampling, Estimation of population proportion, Stratified, Optimum Allocation, Practical difficulty in adopting Neyman Allocation, formation of strata. Systematic sampling. PPS sampling, Multistage sampling. Ratio and Regression methods of estimation in various sampling designs.

**Unit III:** The structure and formation of a linear programming problem, Graphical and simplex procedure, Two phase methods, and Charné's-M method with artificial variables ; duality theorem. Transportation and Assignment problems, Routing and traveling salesman problem. Inventory problems – Deterministic models of inventory , Economic Lot size formula ,instantaneous production case ,finite production rates situation ,cases when shortages are allowed /not allowed. Stochastic inventory models – a single period model with no set up cost.

#### **UNIT-IV**

Acceptance sampling plans for attribute inspection ; single, double and sequential sampling plans and their properties ; Bayesian sampling plan. Plans for inspection by variables for one-sided and two-sided specifications; Continuous sampling plans of Dodge type and Wald-Wolfowitz type and their properties

**UNIT-V:** Life distributions ; common life distributions-exponential, Weibull, gamma etc. Estimation of parameters and tests in these models. Notions of ageing ; IFR, IFRA, NBU, DMRL, and NBUE Classes and their duals ; loss of memory property of the exponential distribution ; closures of these classes under formation of coherent systems, convolutions and mixtures. Univariate shock models and life distributions arising out of them ; bivariate shock models ; common bivariate exponential distributions and their properties. Reliability estimation based on failure times in variously censored life tests and in tests with replacement of failed items.

#### **References:**

1. Freedman,P.,”The Principles of Scientific Research,2<sup>nd</sup> ed.,new York Pergamon Press,1960
2. Gaum,Carl G.,Graves ,Harod F.,and Hoffman ,Lyne,S.S.,Report Writing ,New York : Barnes & Noble ,Inc,1956.
3. 3. Weller,S.;Romney,A,”Systematic Data Collection “,(Qualitative Research Method Series 10)
4. C.R.Kothari,”Research Methodology”,Second Edition,Wishwa Publication,Wiley Eastern Limited,New Delhi.
5. Mukhopadhyay, P. (1998): Theory and methods of Survey Sampling , Prentice-Hall of India Pvt. Ltd. New Delhi.
6. Sukhatme ,P.V. Sukhatme,B.V. Sukhatme S. and Ashok,C.(1984):Sampling Theory of Survey with Applications, IASRI Publication, New Delhi.



**PT. RAVISHANKAR SHUKLA UNIVERSITY RAIPUR (C.G.)**

**B.Ed. SYLLABUS 2019-21**

Paper No	PAPER NAME	EXTERNAL	INTERNAL
			THEORY/PRACTICAL
<b>SEMESTER I</b>			
	<b>THEORY</b>		
Paper 1	Philosophical Perspectives of Education	80	20
Paper 2	Nai Talim: An Experiential Learning	80	20
Paper 3	Pedagogy Part I	80	20
	<b>PRACTICUM</b>		
	Preparation of Teaching Aids 01. Minimum 6 charts on school contain 02. Minimum 5 sets of Transparency to Transact school content 03. Minimum 2 Power Point Presentations to transact school content 04. Minimum one static model to aid school teaching content		50
	Community Activities 1. Village Survey 2. Awareness Rally/Program		50
<b>SEMESTER II</b>			
	<b>THEORY</b>		
Paper 4	Sociological Perspectives of Education	80	20
Paper 5	Learner and Learning Process	80	20
Paper 6	Elective I	80	20
Paper 7	Curriculum and Knowledge	80	20
	<b>PRACTICUM</b>		
	Micro Teaching on Skills of Teaching Internship (Two weeks) School Experience a) Observation of School Documents b) Mentor's Report		50
<b>SEMESTER III</b>			
	<b>THEORY</b>		
Paper 8	Pedagogy Part II	80	20
Paper 9	Nai Talim: Skill Based Learning	80	20
	<b>PRACTICUM</b>		
	Internship (Eighteen Weeks)		100
	Reflective Diary & Supervisor's Assessment		50
<b>SEMESTER IV</b>			
	<b>THEORY</b>		
Paper 10	Gender, School and Society	80	20
Paper 11	Assessment in Learning	80	20
Paper 12	Elective II	80	20
	<b>PRACTICUM</b>		
	Training in Yoga and Sports & Games		50
	Psycho-Metric Assessment	50	
	Viva Voce on Teaching Experience	100	
	<b>TOTAL</b>	1110	240 + 350 = 590
	<b>GRAND TOTAL</b>	1700	

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# Curriculum Framework

## B.ED. TWO YEAR COURSE 2019-2021.

Curriculum Organization based on NCTE framework			
Semester I	Semester II	Semester III	Semester IV
THEORY	THEORY	THEORY	THEORY
(C) Philosophical perspectives of Education (4 credits)	(C) Sociological perspectives of Education (4 credits)	(S) Pedagogy II (4 credits)	(C S) Gender, School & Society (4 credits)
(C) Nai Talim: An Experiential Learning (4 credits)	(C) Learner & Learning Process (4 credits)	(T E) Nai Talim: Skill Based Learning (2 credits)	(T E) Assessment in Learning (4 credits)
	(E) Elective I (4 credits)		(E) Elective II (4 credits)
(S) Pedagogy I (4 credits)	(T E) Curriculum & Knowledge (2 credits)		
PRACTICUM	PRACTICUM	PRACTICUM	PRACTICUM
Preparation of Teaching Aids (2 credits) Community Activities (2 credits)	Internship (2 Weeks) (2 credits) School Experience I (2 credits) a) Observation report of school documents b) Mentor's Report. c) Micro Teaching	Internship (18 Weeks) (12 credits) Reflective Diary (2 credits) Supervisor's Assessment (2 credits)	Training in Yoga and Sports (2 Credits) Psycho-Metric Assessment (2 credits) Teaching Exam & Viva Voce on Teaching
12 + 4 = 16 Credits	14 + 4 = 18 Credits	6 + 16 = 22 Credits	12 + 4 = 18 Credits
C: Core Paper, E: Elective Paper, TE: Teacher Enrichment, CS: Contemporary Study			

### PSYCHOLOGY PRACTICALS

At least 5 practical's have to be conducted. Out of which 2 is compulsory.

01. Aptitude Test in any school subject (Compulsory)
02. Case Study to measure the problematic behavior of the child (Compulsory)
03. Achievement Test in any school subject with findings difficulty level only
04. Value Test
05. Reasoning Ability Test
06. Testing Individual differences/ Intelligence Test
07. Transfer of Learning
08. Span Of Attention

Note: "Subject" is compulsory to be present with the trainee during the annual Psychometric Practical Examination.


### TEACHING PRACTICALS

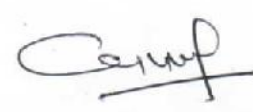
During Annual Teaching Viva voce Practical Exam it is compulsory to produce all teaching related work from Semester I to III.

18 Lesson plan (9 each from Middle and High School) including 08 lesson plan is compulsory from the Nai Talim formate). (10 Lesson Plan+8 Nai Talim=18)

Note: Formate has been given at the end of the syllabus.

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## B.ED. SYLLABUS (SEMESTER I)

### PAPER - I

### PHILOSOPHICAL PERSPECTIVE OF EDUCATION

MARKS 80

#### Aims of the Course:

**To enable the student- teacher to understand**

1. The relationship between Philosophy and Education and implications of philosophy on education.
2. The importance and role of education in the progress of Indian society.
3. The contribution of great educators to the field of education.
4. The need to study education in a sociological perspective. The process of social change and socialization to promote the development of a sense of commitment to the teaching profession and social welfare.
5. Their role in creation of a new social order in the country and learn about various social welfare opportunities in which they can participate helpfully.
6. The means and measures towards the promotion of National integration and protection of human rights.

#### Course Outline:

#### UNIT-I: AIMS OF EDUCATION

- Education Nature and Meaning its objectives/ aims in relation to the time and place.
- Educational aims in the Western context: with specific reference to Russell, Dewey. Their impact on educational thought and class room practices, in term of progressive trends in education.
- Educational aims in the Indian context with specific reference to Indian thinkers such as Gandhi, Tagore.
- Philosophy and Education: Significance of studying philosophy in understanding educational practices and problem.

#### UNIT – II: PHILOSOPHICAL SYSTEMS

Major Philosophical systems - their salient features and their impact on education.

- Realism with reference to Aristotle and Jainism.
- Naturalism with reference to the view! of Rousseau and Rabindra Nath Tagore.
- Idealism with reference to Plato. Socrates and Advaita Philosophy.
- Pragmatism with reference to Dewey "instrumentalism & Experimentalism"

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- Humanism: Historical, Scientific and Buddhists.

### UNIT-III : INDIAN THINKERS

- Educational thinkers and their contribution in developing principles of education.
- M.K. Gandhi Basic tenets of Basic education.
- Gijju Bhai The world of the child.
- Swami Vivekananda : Man making education.
- Sri Aurobindo Integral education, its basic premises; stages of development.
- J. Krishna Murthy; Child Centered Education.

### UNIT – IV: WESTERN THINKERS

- JJ Rousseau
- John Dewey
- Antonio Gramsci ( Neo- Gramscian Theory)
- Paulo Friere (Democratic Education)

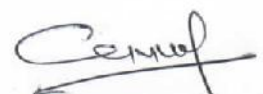
### UNIT – V: CONTEMPORARY THOUGHT

- Critical and comparative study of the period and socio- political perspective of the western and Indian Thinkers.
- Contemporary philosophical perspectives of Education; Modernization, globalization in thought and education

### REFERENCES:

1. Anand C.L. et.al. : Teacher and Education in Emerging India, NCERT, New Delhi.
2. Anant Padmnabhan : Population Education in Classrooms, NCERT, New Delhi.
3. Bhatnagar, S.: Adhunik Bhartiya Shiksha Aur Uski Samasyayen, Lyall Book Depot, Meerut.
4. Chakravorty M.: Gandhian Dimension in Education Daya Publishing House New Delhi.
5. Mani R.S.: Educational ideas and ideals of Gandhi and Tagore, New Book Society, New Delhi.
6. Ministry of Human Resource Development: National Policy on Education, 1996, New Delhi.
7. Mohanty Jagannath: Indian Education in Emerging Society, Sterling Publication, New Delhi.
8. Pandey, Shyam Swaroop: Shiksha ki Darshanik evam Samajik Shastriya Pursht Bcomi Vinod Pustak Mandir, Agra.

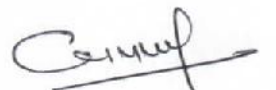
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9. Pathak and Tyagi : Shiksha ke Samnya Siddhant, Vinod Pustak Mandir, Agra.
10. Pathak, RD. and Tyagi, I.S.D. Shiksha ke Samariya Siddhant. Vinod Pustak Mandir, Agra.
11. Saxena, N.R. Swaroop Shiksha Ke Samanya Siddhant, Lall Book Depot, Meerut.
12. Singh B.P.: Alms of Education in India, Ajanta Publication New, Delhi.
13. Agrawal, J.C.: Nai Shiksha Niti. Prabhat Prakashan, Delhi.
14. Bhatnagar, R.P. Technology of Teaching, International Publishing House, Meerut.
15. Freire, Paulo; Pedagogy of the oppressed, Translated by Myra Bergaman Ramos, The Continuum Publishing Corporation, New York, NY, 1987.
16. Freire, Paulo; The politics of Education- Culture, Power, Liberation, Translated by Donoldo Mecedo, Bergin & Garvey, New York, NY, 1985.
17. Bhatnagar, Suresh Shiksha Ki Samasyaen, Lyall Book Depot, Meerut.
18. Bhooshan, Shailendra & Anil Kumar: Shikshan Taknik. Vinod Pustak Mandir, Agra.
19. Manav Sansadhan Vikas mantralaya: Rashtriy Shiksha Niti 1986. New Delhi.
20. Safaya. Raghunath,. School Sangathan, Dhanpat Ram & Sons, Delhi.
21. Sampath, K.: Introduction to Educational Technology, Sterling Publishers, New Delhi.
22. Saxena, N.R. Swaroop, Shikshan Kala Ewam Paddatiyan. Lyall Book Depot, Meerut.
23. Sharma & Sharma Secondary Education and teacher Functions, Radha Publisher Mandir Agra.
24. Higher Education in India ; Albach

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**PAPER 11****NAI TALIM: AN EXPERIENTIAL LEARNING****MARKS 80****Aims of the Course:****To enable the student-teacher to understand**

1. Understand the concept of local community engagement in teacher education
2. Understand the context of the child from various backgrounds & occupations.
3. Know the school education programs and policies which have local community engagement aspects.
4. Learn the process of connecting the text with the Child/learner within the local Context
5. Distinguish traditional from constructivist approaches of local community engagement
6. Train in usage of dialogic method of community engagement
7. Train in usage of organic intellectual approach for local community engagement
8. Experiential learning of best practices in community engagement
9. Participate effectively in the local community service
10. Develop insights and field realities on indignity and indigenous models.
11. Understand and practice models of Tagore, Gandhi, Shyama Prasad Mukherji for rural reconstruction
12. Explore models of art, craft for entrepreneurship for self-reliance.
13. Understand various real, community stories of children, families.
14. Discover latent talents in the traditional occupations to promote them
15. Devise contextually suitable engagement activities.
16. Promote local occupations with literacy, technology integration and research to develop entrepreneurs

**Unit I: Nai Talim- An Introduction**

- Introduction of Nai Talim and its significance in Indian context, historical perspectives.
- Concept, Aims, Objectives and Scope of Nai-Talim
- Main Principles of Basic Education
- Nai Talim in NCF-2005, NCFTE-2010, RTE-2009 and its Educational Implication

**Unit II: Social and Philosophical Perspectives of Nai Talim**

- Gandhian thoughts and Philosophy
- Gandhian Philosophy and Aims of Education
- Models of Education, Approach to Learning- Constructivism, Paulo Freire Critical Pedagogy and Dialog Method
- Course outline at Primary, Middle and Secondary Level

**Unit III: Work Based Learning and Community Involvement**

- Principle of Community Involvement
- Nai Talim and Craft Education
- Nai Talim and Moral Education
- Agencies of School & Society
- Self Help Groups

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#### Unit IV: Planning and Organization of Skill Development

- Methods of Skill Development
- Establishment of Experimental Education and Rural Education
- Connecting Knowledge to life outside the School.
- Execution of digitalization
- Importance of Renewable Energy

#### Unit V: Health & Hygiene

- Nutrition - Balance Diet
- Communicable and non communicable Disease & its Prevention
- First Aid
- Personal & Community Hygiene

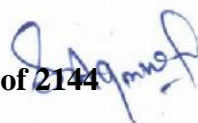
#### Practicum

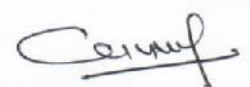
- Panel discussion
- Group Project
- Village Involvement - Gram Sabha, Panchayat
- Interaction with different cottage industry workers
- Craft work and exhibition for social work

#### REFERENCES

1. Ministry of Education, GOI. 1949. *Report of the University Education Commission (1948-49)*, New Delhi.
2. *Report of the Secondary Education Commission (1952-53)*, New Delhi.
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4. *Report of the National Commission on Teachers (1983-84)*, New Delhi.
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## PEDAGOGY (Part I)

SEMESTER - I

PAPER-III

## PEDAGOGY TEACHING OF HINDI

(हिंदी भाषा शिक्षण)

MARKS 80

## एक परिचय

राष्ट्रीय पाठ्यचर्या की रूपरेखा 2005 अमयापकों की भूमिका में एक बड़ी तब्दीली की मांग करती है। पाठ्यचर्या में अब तक अमयापकों को ही ज्ञान के स्रोत के रूप में केन्द्रीय स्थान मिलता रहा है, वह सीखने-सिखाने की समूची प्रक्रिया के संरक्षक और प्रबंधक के रूप में मुख्य भूमिका निभाने का काम करते आए हैं। पर 2005 की स्कूली पाठ्यचर्या उनसे मांग करती है कि वे सूचनाओं के वितरक और ज्ञान के स्रोत बन कर न रहें बल्कि विद्यार्थियों द्वारा ज्ञान हासिल करने की प्रक्रिया में स्वयं को सहायक मानें। वे विद्यार्थियों को शिक्षा-प्रक्रिया में सक्रिय भागीदार के रूप में देखें और उनके सवालों को सुनने और समझने की जरूरतों को समझें। इन सब तब्दीलियों को उनके व्यवहार का हिस्सा बनाने के लिए जरूरी है कि अध्यापक शिक्षा के पाठ्यक्रम में बदलाव आए। स्कूली व्यवस्था में बदलाव की पहल तभी संभव है जब इस व्यवस्था से जुड़े लोगों के दृष्टिकोण में परिवर्तन आए और अध्यापक की भूमिका इस व्यवस्था में सबसे महत्वपूर्ण है। इस दृष्टि से भाषा-शिक्षण का पाठ्यक्रम और भी महत्वपूर्ण हो जाता है क्योंकि भाषा पूरी शिक्षा की जमीन तैयार करती है जहां सिर्फ भाषा पढ़ना सीखना नहीं बल्कि भाषा के जरिये और विषयों में भी निपुणता हासिल करने की बात आती है। इसके साथ ही भाषा से जुड़े नए मुद्दे जैसे बहुभाषिक कक्षा, समझ का माध्यम, शांति की शिक्षा में भाषा की भूमिका आदि की समझ अध्यापकों के लिए जरूरी है जो अध्यापक शिक्षा में व्यापक बदलाव की मांग करते हैं। यह पाठ्यक्रम भाषा के नए सरोकारों और सीखने-सिखाने की नई दृष्टियों को म्यान में रखकर तैयार किया गया है। हमें आशा है कि प्रशिक्षु अध्यापकों को इससे भाषा-शिक्षण की तैयारी में सहायता मिलेगी।

## हिंदी भाषा-शिक्षण का पाठ्यक्रम

## पाठ्यक्रम के विशेष उद्देश्य

- भाषा के अलग-अलग भूमिकाओं को जानना
- भाषा सीखने की सृजनात्मक प्रवृत्ति को जानना
- भाषा के स्वरूप और व्यवस्था को समझना
- स्कूल की भाषा, बच्चों की भाषा और समझ के बीच के संबंध को जानना
- भाषा के संदर्भ में पढ़ने के अधिकार, शांति और पर्यावरण के प्रति सचेत होना
- भाषा सीखने के तरीके और प्रक्रिया को जानना और समझना
- पाठ्यचर्या, पाठ्यक्रम और पाठ्यपुस्तक का विश्लेषण कर कक्षा विशेष और बच्चों की समझ के अनुसार ढालना
- भाषा और साहित्य सम्बंध को जानना

- हिंदी भाषा के विविध रूपों और अभिव्यक्तियों को जानना
- भावों और विचारों की स्वतंत्रा अभिव्यक्ति करना
- भाषायी बारीकियों के प्रति संवेदनशील होना
- अनुवाद के महत्त्व और भूमिका को जानना
- विद्यार्थियों की सृजनात्मक क्षमता को पहचानना
- बच्चों के भाषायी विकास के प्रति समझ बनाना और उसे समुन्नत करने के लिए विद्यालय में तरह-तरह के मौके जुटाना
- भाषा के मूल्यांकन की प्रक्रिया को जानना
- साहित्यिक और गैर-साहित्यिक मौलिक रचनाओं की समझ और सराहना
- भाषा सीखने-सिखाने के सृजनात्मक दृष्टिकोण को समझना

### Course Outline:

#### इकाई - 1: भाषा की भूमिका

(बच्चा जब स्कूल आता है तो उसके पास भाषा का एक रूप मौजूद होता है। कक्षा में बच्चों की भाषा इस रूप को सम्मान देने से उसका आत्मविश्वास बढ़ेगा, यह सीखने की बुनियाद है।)

- 1 समाज में भाषा - भाषा और लिंग, भाषा और सत्ता भाषा और अस्मिता, भाषा और वर्ग
- 2 विद्यालय में भाषा - घर की भाषा और स्कूल की भाषा, समझ का माध्यम (बच्चे की भाषा) समूचे पाठ्यक्रम में भाषा, ज्ञान सृजन और भाषा, माध्यम भाषा: एक आलोचनात्मक दृष्टि, विषय के रूप में भाषा और माध्यम भाषा में अंतर, विविध भाषिक प्रयुक्तियाँ बहुभाषिक कक्षा, शिक्षक-शिक्षार्थी संबंध के पहलू के रूप में भाषा
- 3 संविधान और शिक्षा समितियों के रिपोर्ट में भाषा - भाषाओं की स्थिति (धारा 343-351, 350।) कोठारी कमीशन (64 से 66) राष्ट्रीय शिक्षा नीति - 1986, पी.ओ. 2005 (भाषा अमययन) ए-1992, राष्ट्रीय पाठ्यचर्या -

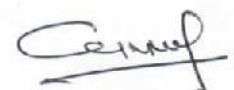
#### गतिविधि/पोर्टफोलियो

#### प्रशिक्षण के दौरान

छोटे समूह में बांट कर भारतीय भाषाओं के लिए निर्मित पोजीशन पेपर का अध्ययन और उस पर चर्चा।

- विज्ञान, समाज विज्ञान और गणित की कक्षा VI से VII की किताबों से कुछ अंश चुनकर निम्नलिखित बिंदुओं को ध्यान में रखते हुए विश्लेषण करिए-
- विभिन्न भाषिक प्रयुक्तियों को कैसे प्रस्तुत किया गया है।
- उस अंश में प्रयुक्त भाषा विषय संबंधी भाव स्पष्ट करने में कहाँ तक समर्थ है।
- बच्चे के स्तर के अनुरूप हैं?

 R. Kumar





- क्या इसमें तकनीकी भाषा का बहुत इस्तेमाल किया गया है ?
- क्या यह भाषा सीखने में सहायक है?

### कक्षा-शिक्षण के दौरान

- कक्षा-शिक्षण के दौरान बच्चों के परिवेश और उनकी भाषा के बारे में जानकारी प्राप्त करें और बहुभाषिकता को स्रोत के रूप में इस्तेमाल करते हुए हिंदी शिक्षण की एक कक्षा-प्रविधि तैयार करें

### परियोजना कार्य

- संविधान में भारतीय भाषाओं संबंधी अनुसंधान तथा राष्ट्रीय शिक्षा नीति, पी.ओ.ए. द्वारा संस्तुत भाषा संबंधी सिफारिशों पर एक रिपोर्ट तैयार करना ।
- कक्षा छह से बारह तक के हिंदी की किताबों में लिंग और शांति संबंधी बिंदुओं की सूची तैयार कर उसके लिए कक्षा प्रविधि तैयार करना ।
- अपने आस-पास के पांच स्कूलों का दौरा कर यह जानकारी प्राप्त करते हुए एक रिपोर्ट तैयार करें कि त्रिभाषा सूत्र की क्या स्थिति है?

### इकाई - 2: हिंदी भाषा की स्थिति और भूमिका

हिंदी भाषा की भूमिका: स्वतंत्रता से पहले और स्वतंत्रता के बाद हिंदी, हिंदी के विविध रूप, अंतर्राष्ट्रीय स्तर पर हिंदी, ज्ञान की भाषा के रूप में हिंदी, हिंदी पढ़ने-पढ़ाने की चुनौतियाँ।

### गतिविधि / पोर्टफोलियो

#### प्रशिक्षण के दौरान

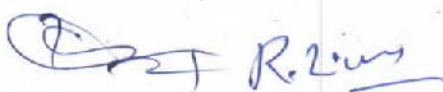
- स्वातन्त्र्योत्तर भारत में हिंदी की भूमिका पर समूह में चर्चा करें।
- जब शब्द नहीं रहते तब शस्त्र उठते हैं विषय पर परिचर्चा का आयोजन

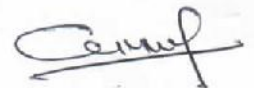
#### कक्षा-शिक्षण के दौरान

- चुने हुए कुछ कक्षाओं में बच्चों की भाषा का जायजा लेते हुए हिंदी के विविध रूपों पर एक रिपोर्ट तैयार करें।
- रोजमर्रा की जिंदगी में प्रयोग होने वाली कम से कम बीस क्रियाओं, जैसे नहाना, आना, पकाना, जाना आदि को कक्षा में मौजूद बच्चे किस-किस तरह से प्रयोग करते हैं - इस आधार पर सूची बनाएँ

### परियोजना कार्य

- इस इकाई में दिए गए विषयों को ध्यान में रखते हुए एक प्रश्नावली तैयार करें, दस व्यक्तियों का साक्षात्कार करें इस साक्षात्कार के आधार पर हिंदी की स्थिति पर एक रिपोर्ट लिखें।





- हिंदी भाषा के विकास में क्षेत्रीय जनपदीय हिंदी की भूमिका पर आलेख पाठ करें। (हरेक विद्यार्थी अपने क्षेत्र विशेष को ध्यान में रखते हुए आलेख तैयार करें।)

### इकाई - 3: भाषा शिक्षण पर एक दृष्टि

(हिंदी में विज्ञान, गणित, समाज विज्ञान और कला सब कुछ है पर ये विषय स्वयं हिंदी या भाषा नहीं हैं।)

भाषा सीखने सिखाने की विभिन्न दृष्टियाँ— भाषा अर्जन और अधिगम का दार्शनिक, सामाजिक और मनोवैज्ञानिक आधार, समग्र भाषा दृष्टि, रचनात्मक दृष्टि, भाषा सीखने-सीखाने की बहुभाषिक दृष्टि आदि (जॉनडुई, ब्रूनर, जे. प्याजे, एल. वायगात्स्की, चॉम्स्की आदि) भारतीय भाषा दृष्टि (पाणिनी, कामता प्रसाद गुरु, किशोरी दास वाजपेयी आदि)

भाषा शिक्षण की प्रचलित विधियाँ/प्रणालियाँ और उनका विश्लेषण — व्याकरण अनुवाद प्रणाली, प्रत्यक्ष प्रणाली, ढाँचागत प्रणाली, प्राञ्छतिक प्रणाली, उद्देश्यपरक (अन्तर्विषयक/अन्तर्नुशासनात्मक) संप्रेषणात्मक प्रणाली आदि।

### गतिविधि/पोर्टफोलियो

#### प्रशिक्षण के दौरान

- 'मातृभाषा और अन्य भाषा' विषय पर छोटे समूह में चर्चा करें।

#### कक्षा शिक्षण के दौरान

- भाषा की कक्षा में रचनात्मक दृष्टिकोण को म्यान में रखते हुए चार गतिविधियाँ तैयार करें।

### परियोजना कार्य

- विविध राजभाषा शिक्षा प्रणालियों का अध्ययन करते हुए उनका विश्लेषण कीजिए।

### इकाई - 4: भाषा का स्वरूप

(कोई व्याकरण भाषा की चाल को बदल नहीं सकता। भाषा लोक व्यवहार से परिचालित होती है।)

1. भाषायी व्यवहार के विविध पक्ष— नियमबद्ध व्यवस्था के रूप में भाषा: भाषायी परिवर्तनशीलता (उच्चारण वेफ संदर्भ में) हिंदी की बोलियाँ वाक् तथा लेखन।

2. भाषायी व्यवस्थाएँ— सार्वभौमिक व्याकरण की संकल्पना, अर्थ की प्रकृति तथा संरचना, वाक्य विज्ञान तथा अर्थ विज्ञान की मूलभूत संकल्पनाएँ स्वनिम विज्ञान और रूप विज्ञान, (उपयुक्त उदाहरण देकर पढ़ाए जाएंगे)

### गतिविधि/पोर्टफोलियो प्रशिक्षण/कक्षा शिक्षण के दौरान

- 'लिखित और मौखिक भाषा में अंतर' विषय पर समूह में चर्चा करें









### इकाई -5: भाषायी दक्षताएँ

1. संदर्भ में भाषा – संदर्भ में व्याकरण और संदर्भ में शब्द
2. भाषायी दक्षताएँ— सुनना, बोलना, पढ़ना और लिखना
  - सुनना और बोलना – सुनने का कौशल, बोलने का लहजा— भाषाई विविधता और हिंदी पर इसका प्रभाव, पढ़ने—पढ़ाने पर इसका प्रभाव, सुनने और बोलने के कौशल विकास के स्रोत और सामग्री, रोलप्ले, कहानी सुनाना, परिस्थिति के अनुसार संवाद, भाषा लैब, मल्टीमीडिया तथा मौलिक सामग्री की सहायता से संप्रेषणात्मक वातावरण का निर्माण
  - पढ़ना – पढ़ने के कौशल, पढ़ने के कौशल विकास में समझ का महत्व, मौन और मुखर पठन, गहन—पठन, विस्तृत पठन, आलोचनात्मक पठन, पढ़ने के कौशल विकास में सृजनात्मक साहित्य (कहानी, कविता आदि) सहायक, थिसॉरस, शब्दकोश और इन्साइक्लोपीडिया का उपयोग/महत्व
  - लिखना – लिखने के चरण, लेखन—प्रक्रिया, सृजनात्मक लेखन, औपचारिक और अनौपचारिक लेखन (कहानी, कविता, संवाद, डायरी, पत्र, रिपोर्ट, समाचार आदि)

### गतिविधि/पोर्टफोलियो

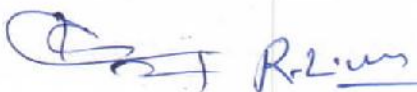
- सभी भाषायी कौशलों के सीखने से सम्बंधित 4-4 गतिविधियाँ तैयार करें और उनका कक्षा शिक्षण के दौरान प्रयोग करें।
- पढ़ने के कौशल विकास को ध्यान में रखते हुए कक्षा छह हिंदी के विद्यार्थी के लिए तीन गतिविधियाँ तैयार करें और उनका कक्षा शिक्षण के दौरान प्रयोग करें।
- सभी विद्यार्थी कक्षा छह से आठ के हिंदी पाठ्यपुस्तकों से संदर्भ में व्याकरण के दस नमूने इकट्ठा करें और उन पर समूह में चर्चा करें।

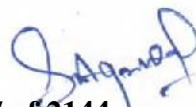
### परियोजना कार्य :-

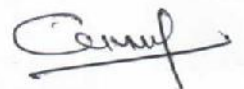
- सुनने और बोलने में असमर्थ बच्चों को ध्यान में रखते हुए हिंदी शिक्षण की दो गतिविधियाँ तैयार करें

### संदर्भ :-

- 1.भाई योगेन्द्रजीत : हिन्दी भाषा शिक्षण,विनोद पुस्तक मंदिर आगरा
- 2.क्षत्रिय के : मात्रभाषा शिक्षण,विनोद पुस्तक मंदिर आगरा
- 3.लाल रमन बिहारी : हिन्दी शिक्षण,रस्तोगी पब्लिकेशन,मेरठ।
- 4.सफाया,रघुनाथ : हिन्दी शिक्षण,विधि,पंजाब किताब घर जालंधर।
- 5.शर्मा,डॉ.लक्ष्मीनारायण : भाषा 1,2 की शिक्षण विधियाँ और पाठ नियोजन, ,विनोद पुस्तक मंदिर आगरा
- 6.शर्मा,राजकुमारी : हिन्दी शिक्षण,राधा प्रकाशन मंदिर आगरा।
- 7.सिंह सावित्री : हिन्दी स्थल बुक डिपो मेरठ।





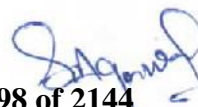
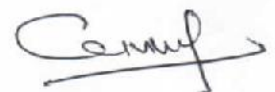


**PAPER III****PEDAGOGY OF LANGUAGE (ENGLISH)****MARKS 80**

School education and teacher-education share a symbiotic relationship. To have qualitative improvement in education, both teacher-education and school education need to mutually reinforce each other. NCF-2005 and the Right to Education Act, 2009 suggest a rethinking in the area of teacher-education as well. A need to review and redesign the B.Ed. Syllabus was felt as NCF-2005 expects the teacher to look at school education in a holistic manner. It advocates learner-centred learning rather than teacher-centred teaching. Teacher's attitude, aptitude and motivation play an important role because the teacher needs to engage with the learning process of the learner. Teacher as a facilitator helps learners construct their knowledge. The teacher should be able to participate meaningfully to transact the syllabus and textbooks effectively along with teaching-learning materials. Therefore, the teacher should be well-versed not only with the subject content but also with the pedagogy of learning.

**Aims of the Course:****To enable the student- teacher to understand**

- Understand the different roles of language;
- Understand the relation between literature and language;
- Understand and appreciate different registers of language;
- Develop creativity among learners;
- Understand the role and importance of translation;
- Examine authentic literary and non-literary texts and develop insight and appreciation;
- Understand the use of language in context, such as grammar and vocabulary;
- Develop activities and tasks for learners;
- Understand the importance of home language and school language and the role of mother tongue in education;
- Use multilingualism as a strategy in the classroom situation;
- Develop an understanding of the nature of language system;
- Understand about the teaching of poetry, prose and drama;
- Identify methods, approaches and materials for teaching English at various levels in the Indian context;
- Understand constructive approach to language teaching and learning;
- Develop an insight into the symbiotic relationship between curriculum syllabus and textbooks;



- Develop and use teaching aids in the classroom both print and audio-visual material, and ICT (internet and computer technology);
- Understand the process of language assessment;
- Understand need and functions of language lab;
- Sensitise teacher-students about emerging issues, such as right to education for children,
- Peace and environment education in context with language teaching; and familiarise students with our rich culture, heritage and aspects of our contemporary life.
- Language classroom and texts have a lot of scope to make students sensitive towards surroundings, people and the nation.

### Course Outline:

#### UNIT I: ROLE OF LANGUAGE

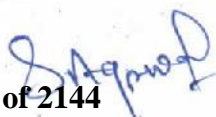
1. LANGUAGE AND SOCIETY: Language and Gender; Language and Identity; Language and Power; Language and Class (Society).
2. LANGUAGE IN SCHOOL: Home language and School language; Medium of understanding (child's own language); Centrality of language in learning; Language across the curriculum; Language and construction of knowledge; Difference between language as a school- subject and language as a means of learning and communication; Critical review of Medium of Instruction; Multilingual classrooms; Multicultural awareness and language teaching.
3. CONSTITUTIONAL PROVISIONS AND POLICIES OF LANGUAGE EDUCATION: Position of Languages in India; Articles 343-351, 350A; Kothari Commission (1964-66); NPE- 1986; POA-1992; National Curriculum Framework-2005 (language education).

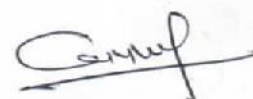
#### Activities:

Discussion on Position paper on 'Teaching of English'

- Position paper on 'Teaching of Indian Languages'
- 'Multilingualism as a Resource'
- Analysis of advertisements aired on Radio/Television on the basis of language and gender.
- Take a few passages from Science, Social Science and Maths textbooks of Classes VI to VII and analyses:
  - (i) How the different registers of language have been introduced?
  - (ii) Does the language clearly convey the meaning of the topic being discussed?
  - (iii) Is the language learner-friendly?
  - (iv) Is the language too technical?
  - (v) Does it help in language learning?
- Now write an analysis based on the above issues.

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### Project

- Prepare a report on the status of languages given in the Constitution of India and language policies given in Kothari Commission, NPE-SYLLABUS FOR TWO-YEAR BACHELOR OF EDUCATION 1986, and POA-1992.
- Visit five schools in the neighbourhood and prepare a report on the three language formula being implemented in the schools.
- Teaching Practice
- Talk to the students and find out the different languages that they speak.
- Prepare a plan to use multilingualism as a strategy in the English classroom.
- On the basis of the English Textbooks (VI to XII) prepare a list of Topics and activities given on: (i) Language and Gender (ii) Language and Peace. Write a report on their reflection in the textbooks.

### UNIT II: POSITION OF ENGLISH IN INDIA

- **ROLE OF ENGLISH LANGUAGE IN THE INDIAN CONTEXT:** English as a colonial language,
- English in Post-colonial times; English as a language of knowledge; Position of English as second language in India; English and Indian languages; English as a link language in global context; challenges of teaching and learning English.
- **Activities**
  - Discuss in groups how the role of English language has changed in the twenty-first century.
  - Topic for Debate: Globalisation and English
  - Discussion on the topic 'War Begins When Words Fail'
  - Keeping in view the topics given in this unit, prepare a questionnaire.
  - Interview ten people and write a report on 'English Language in India'.
- **Project:**
  - Do a survey of five schools in your neighbourhood to find out:
    1. Level of Introduction of English
    2. Materials (textbooks) used in the classroom
  - Prepare a report on the challenges faced by the teachers and the learners in the teaching- learning process.

### UNIT III: AN OVERVIEW OF LANGUAGE TEACHING

1. DIFFERENT APPROACHES/THEORIES TO LANGUAGE LEARNING AND TEACHING (MT & SL)
  - Philosophical, social and psychological bases of approaches to Language acquisition and Language learning; inductive and deductive approach; whole language approach;

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constructive approach; multilingual approach to language teaching (John Dewey, Bruner, J. Piaget, L. Vygotsky, Chomsky, Krashen), and Indian thought on language teaching.

## 2. A CRITICAL ANALYSIS OF THE EVALUATION OF LANGUAGE TEACHING METHODOLOGIES:

- Grammar **translation method, direct method, Structural-situational method, bilingual** method, communicative approach.
- Activities
  - Discussion on the topic 'Mother Tongue and Other Tongue'
- Project
  - Do a comparative study of positive features and weaknesses of different approaches to language learning.
- Teaching Practice
- Prepare four activities keeping in view 'Constructivism in a Language Classroom'.

## UNIT IV: NATURE OF LANGUAGE

1. ASPECTS OF LINGUISTIC BEHAVIOUR: Language as a rule-governed behaviour and linguistic variability; Pronunciation—linguistic diversity, its impact on English, pedagogical implication; Speech and writing.
2. LINGUISTIC SYSTEM: The organisation of sounds; The structure of sentences; The concept of Universal grammar; Nature and structure of meaning; Basic concept in phonology, morphology, syntax and semantics; Discourse.

### Activities

- Have a discussion on the topic 'Difference Between Spoken and Written Language'.

## UNIT 5: ACQUISITION OF LANGUAGE SKILLS

1. Grammar in context; vocabulary in context
2. Acquisition of language skills: Listening, speaking, reading and writing.
  - Listening and Speaking: Sub skills of listening: Tasks; Materials and resources for developing the listening and speaking skills: Storytelling, dialogues, situational conversations, role plays, simulations, speech, games and contexts, language laboratories, pictures, authentic materials and multimedia resources
  - Reading: Sub skills of reading; Importance of understanding the development of reading skills; Reading aloud and silent reading; Extensive and intensive reading; Study skills, including using thesauruses, dictionary, encyclopedia, etc.
  - Writing: Stages of writing; Process of writing; Formal and Informal writing, such as poetry, short story, letter, diary, notices, articles, reports, dialogue, speech, advertisement, etc; Reference skills; Study skills; Higher order skills.
- Activities
  - Collect ten examples of Grammar in context from English Textbooks of Classes VI to

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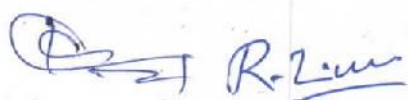
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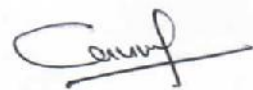
VIII and have a group discussion.

- Teaching Practice
- Prepare activities for listening, speaking, reading and writing. (5 Each)
- Prepare three activities to develop the reading skills of Class VI students.
- Project
  - Keeping in view the needs of the children with special needs prepare two activities for English teachers.

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### PAPER III:

#### PEDAGOGY OF SOCIAL SCEINCES

MARKS 80

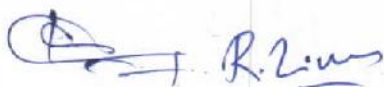
This course in the teaching of Social Sciences introduces student teachers to matters of both content and pedagogy. Some emphasis on content seems necessary in view of the fact that many student teachers may not be having sufficient exposure to four major disciplines of Social Sciences. In fact, the pedagogy of a field of enquiry cannot be separated from its content. This course will help student teachers understand key concepts of the various Social Sciences as well as related pedagogical issues. Furthermore, student teachers should be encouraged to see interconnections between the different Social Sciences, i.e. see Social Sciences as an integrated area of study.

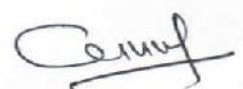
Social and economic issues and the concerns of Indian society have been introduced through real-life situations and primary sources of information. *Student-teachers are encouraged to grasp concepts and to develop thinking skills.* That is why, in certain cases, Case Studies for the transactions of topics have been indicated.

#### Aims of the Course:

##### To enable the student-teacher to understand

- To develop an understanding of the nature of Social Sciences, both of individual disciplines comprising Social Sciences, and also of Social Sciences as an integrated/interdisciplinary area of study;
- To acquire a conceptual understanding of the processes of teaching and learning Social Sciences
- To enable student teachers examine the prevailing pedagogical practices in classrooms critically and to reflect on the desired changes;
- To acquire basic knowledge and skills to analyse and transact the Social Sciences curriculum effectively following wide-ranging teaching-learning strategies in order to make it enjoyable and relevant for life;
- To sensitize and equip student teachers to handle social issues and concerns in a responsible manner, e.g., preservation of the environment, disaster management, promoting inclusive education, preventing social exclusion of children coming from

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socially and economically deprived backgrounds, and saving fast depleting natural resources (water, minerals, fossil fuels etc.).

### Course Outline:

#### UNIT I: SOCIAL SCIENCES AS AN INTEGRATING AREA OF STUDY: CONTEXT AND CONCERNS

- Distinguishing between Natural and Social Sciences: Major Social Sciences disciplines in Schools.
- What is 'social' about various Social Sciences?
- Uniqueness of disciplines vis-a-vis interdisciplinarity
- Linking child's natural curiosity with natural phenomena like weather, flora and fauna; spatial and temporal contexts; important social and economic issues and concerns of the present-day Indian society.
- Multiple perspectives/plurality of approaches for constructing explanations and arguments.

#### UNIT II: TEACHING-LEARNING RESOURCES IN SOCIAL SCIENCES

- People as resource: The significance of oral data.
- Types of Primary and Secondary Sources: Data from field, textual materials, journals, magazines, newspapers, etc.
- Using the library for secondary sources and reference material, such as dictionaries and encyclopedias.
- Various teaching aids: Using atlas as a resource for Social Sciences; maps, globe, charts, models, graphs, visuals.
- Audio-visual aids, CD-Rom, multimedia, internet.

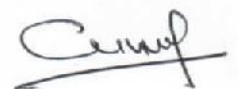
#### UNIT III: SOCIAL SCIENCES CURRICULUM FOR SCHOOLS IN INDIA

- Curriculum development process: National and State levels.
- Studying the Social Sciences syllabus - aims and objectives, content organization and presentation of any State Board and CBSE for different stages of school education.

#### UNIT IV: TEACHING-LEARNING OF GEOGRAPHY—SPACE, RESOURCES AND DEVELOPMENT

- Meaning, Nature and Scope of Geography: Current Trends
- Teaching and Learning Major Themes and Key Concepts in Geography
- LOCATION: Absolute (Grid system of latitudes and longitudes) and relative location: two ways of describing the positions of places and people on the earth's surface. Differentiating between sites (location) and situation (place).
- PLACE: Distinct physical and human characteristic of places that distinguish one from

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the other.

- **MOVEMENTS:** Interdependence and interaction across space, migration of people, transport and communication; trade and commerce, patterns of centres, pathways and hinterlands.
- **REGIONS:** Formation and change.
- The above content may be used to understand teaching, learning strategies and skill development in Geography.
- **Developing Skills in Geography**
- Observation, recording and interpretation of physical and social features and phenomena; Reading and interpreting geographical information through tables, figures, diagrams, photographs; Map reading and interpreting using scale (distance), direction, symbols, point, line and area; Visual-to-verbal and verbal-to-visual transformation leading to mental mapping; Identifying, constructing and asking geographical questions; Developing and gathering relevant information and data and analysing them to answer geographical questions and offering explanations and interpretations of their findings; applying acquired knowledge and skills for understanding the wider world and taking personal decisions; taking up activities to study environmental degradation in the local area and its preservation methods; studying any disaster involving all factors at the local/global levels.
- **Teaching Strategies in Geography**
- Questioning; Collaborative strategies; Games, simulations and role plays; Values clarification; Problem-solving and decision-making.
- **METHODS:** Interactive verbal learning; Experiential learning through activities, experiments; Investigative field visits based on students' own interests with teacher's support as facilitator; Engagement with 'places' at an emotional or sensory level using art, poetry and literature.
- **TECHNIQUES:** Using textbooks and atlas as a part of oral lessons, non-oral working lessons; using medium and large scale maps; using pictures, photographs, satellite imageries and aerial photographs; using audio-visual aids, CDs, multimedia and internet; case study approach.

#### **UNIT V: TEACHING-LEARNING OF ECONOMICS: STATE, MARKET AND DEVELOPMENT**

- As a branch of social science, economics is concerned with people. It studies how to provide them with means to realise their potential. This unit on economics deals with the broad themes of state, market, and development. Market and state are interrelated as instruments of development. The course endeavours to introduce the learners to key economic concepts and issues that affect their everyday lives.
- **Meaning, Nature and Scope of Economics: Current Trends Key Concepts in Economics**
- **Scarcity and choice, opportunity cost, productivity, demand, supply and market mechanism, Division of labour and specialization.**

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- Classification of Economic System
- Capitalism, Socialism, mixed economy (case study: India)
- Developmental Issues in Economics
- Sustainable Development—economic growth and economic development— indicators of measuring the well-being of an economy; Gross Domestic Product; economic planning; Poverty; Food Security; Price rise; Role and functions of Money—formal and informal financial institutions and budget; Classification of Production Activities—primary, secondary and tertiary;
- Economic Reforms and Globalization (discuss these developmental issues with reference to India).
- The above content may be used to understand the teaching, learning strategies and skill development in economics.
- Teaching-Learning Methods in Economics
- In addition to usual methods like lecture, discussion, storytelling, other methods like problem-solving, simulation games, use of media and technology, concept mapping, project and activities like field visits (e.g. visit to a construction site for data on wages and employment), collection of data from documents (e.g. Economic Survey, Five Year Plan), analyzing and interpreting data (using simple tables, diagrams and graphs) can be undertaken. Self-study and collaborative learning activities should be encouraged.
- Teaching-Learning Materials
- Using textbook, analysis of news (Newspaper, TV, and Radio); documents (e.g. Economics Survey, Five Year Plan), Journals and News Magazines.

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**PEDAGOGY OF MATHEMATICS****MARKS 80****Aims of the Course****To enable the student-teacher to understand**

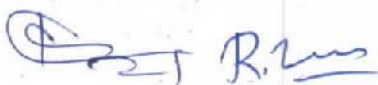
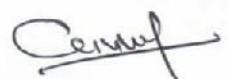
- Develop insight into the meaning, nature, scope and objective of mathematics education;
- Appreciate mathematics as a tool to engage the mind of every student;
- Appreciate mathematics to strengthen the student's resource;
- Appreciate the process of developing a concept;
- Appreciate the role of mathematics in day-to-day life;
- Learn important mathematics: mathematics is more than formulas and mechanical procedures;
- Channelize, evaluate, explain and reconstruct their thinking;
- See mathematics as something to talk about, to communicate through, to discuss among themselves, to work together on;
- Pose and solve meaningful problems;
- Appreciate the importance of mathematics laboratory in learning mathematics;
- Construct appropriate assessment tools for evaluating mathematics learning;
- Develop ability to use the concepts for life skills;
- Stimulate curiosity, creativity and inventiveness in mathematics;
- Develop competencies for teaching-learning mathematics through various measures
- Focus on understanding the nature of children's mathematical thinking through direct observations of children's thinking and learning processes; and
- Examine the language of mathematics, engaging with research on children's learning in specific areas.

**Course Outline:****UNIT 1: NATURE AND SCOPE OF MATHEMATICS**

Meaning and scope of mathematics, A mathematical theorem and its variants—converse, inverse and contra-positive, proofs and types of proofs, Difference between proof and verification; Deductive nature of mathematics; History of mathematics with special emphasis on teaching of mathematics, contribution of Indian mathematicians; Aesthetic sense in mathematics and beauty in mathematics.

**UNIT 2: EXPLORING LEARNERS**

Cultivating learner's sensitivity like intuition, encouraging learner for probing, raising queries, appreciating dialogue among peer -group, promoting the student's confidence (Carrying out

examples from various mathematical content areas, such as Number Systems, Geometry, Sets, etc.).

### UNIT 3: AIMS AND OBJECTIVES OF TEACHING SCHOOL MATHEMATICS

Need for establishing general objectives for teaching mathematics; Study of the aims and general objectives of teaching mathematics vis-a-vis the objectives of school education; writing specific objectives and teaching points of various content areas in mathematics like Algebra, Geometry, Trigonometry, etc.

### UNIT 4: SCHOOL MATHEMATICS CURRICULUM


Objectives of curriculum, principles for designing curriculum, designing curriculum at different stages of schooling, Some highlights of curriculum like vision of school mathematics, main goal of mathematics education, core areas of concern in school mathematics, curricular choices at different stages of school mathematics education, construction of syllabi in various disciplines of mathematics, for example, Algebra, Geometry, etc.; Pedagogical analysis of various topics in mathematics at various level of schooling—Arithmetic (Development of Number Systems), Algebra, Trigonometry, Statistics and Probability, etc.

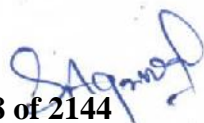
### UNIT 5: APPROACHES AND STRATEGIES IN TEACHING AND LEARNING OF MATHEMATICAL CONCEPTS

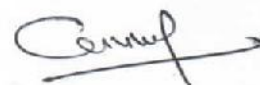
Nature of concepts, concept formation and concept assimilation, Moves in teaching a concept—defining, stating necessary and/or sufficient condition, giving examples accompanied by a reason. Comparing and contrasting; Giving counter examples; Non-examples; Planning and implementation of strategies in teaching a concept like teaching of algebra, geometry, trigonometry, mensuration, etc.; Difference between teaching of mathematics and teaching of science.

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2. One of the oldest Extent digrams from Euclid - Bill Casselman 2008
3. How to teach mathematics –S.K.Arora (Bhimani) : Shanti Publisher's 1998
4. How children learn mathematics – Capeland (New York): M.C.Millan Pub. 1979
5. Mathematics for modern mind – W.R.Fuch (New York): M.C.Millan Pub. 1967
6. Vidyalaya Ganit ke liye sau prayog – J.N.Kapoor (New Delhi): Arya book Depot 1968
7. How to teach mathematics in secondary school – W.B.Saunders (Company) 1967
8. The spirit of mathematics J.N.Kapoor (New Delhi): Arya book Depot 1964
9. Indian Mathematics – Ashok Jhunjunwala (New Delhi) Wiley Eastern Ltd. 1993
10. Curricullum and teaching of mathematics in secondary school , (R.C.Sexena) NCERT 1970
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12. Teaching of essentials of mathematics, Ballard,p.b.

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13. The development of mathematics, Bell, E. T.
14. The teaching of mathematics, Chadha, B. N.
15. The teaching of secondary mathematics, BUTTER & WREN
16. The teaching of arithmetic, C. POTTER, F. F.
17. MATHEMATICS FOR CLASS 9<sup>TH</sup> NCERT
18. MATHEMATICS FOR CLASS 10<sup>TH</sup> NCERT
19. TEACHING OF MATHEMATICS (ENG/HINDI), Dr. S. K. MANGAL
20. TEACHING OF MATHEMATICS (ENG/HINDI), Dr. A. B. BHATNAGER
21. TEACHING OF MATHEMATICS, A. K. KULSHRESTHA.

### PAPER III:

#### PEDAGOGY OF BIOLOGICAL SCIENCE

MARKS 80

#### Aims of the Course:

#### To enable the student-teacher to understand

- Develop insight on the meaning and nature of biological science for determining aims and strategies of teaching-learning;
- Appreciate that science is a dynamic and expanding body of knowledge;
- Appreciate the fact that every child possesses curiosity about his/her natural surroundings
- Identify and relate everyday experiences with learning biological science;
- Appreciate various approaches of teaching-learning of biological science;
- Explore the process skill in science and role of laboratory in teaching-learning;
- Use effectively different activities/experiments/demonstrations/ laboratory experiences for teaching-learning of biological science;
- Integrate the biological science knowledge with other school subjects;
- Analyse the contents of biological science with respect to its branches, process skills, knowledge organisation and other critical issues;
- Develop process-oriented objectives based on the content themes/units;
- Identify the concepts of biological science that are alternatively conceptualised by teachers and students in general;
- Explore different ways of creating learning situations for different concepts of biological science;
- Formulate meaningful inquiry episodes, problem-solving situations, investigatory and

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discovery learning projects based on upper primary, secondary and higher secondary stages, facilitate development of scientific attitudes in learners;

- Examine different pedagogical issues in learning biological science;
- Construct appropriate assessment tools for evaluating learning of biological science;
- Stimulate curiosity, inventiveness and creativity in biological science;
- Develop ability to use biological science concepts for life skills; and
- Develop competencies for teaching, learning of biological science through different measures.

### Course Outline:

#### UNIT I: NATURE AND SCOPE OF BIOLOGICAL SCIENCE

Science as a domain of enquiry, dynamic body of knowledge and as a process of constructing knowledge; Biological Science for environment and health, peace, equity; History of biological science, its nature and knowledge of biological science independent of human application; Origin of life and evolution, biodiversity, observations and experiments in biological sciences; Interdisciplinary linkages, biological sciences and society.

#### UNIT II: AIMS AND OBJECTIVES OF BIOLOGICAL SCIENCE

Developing scientific attitude and scientific temper; Nurture the natural curiosity, aesthetic senses and creativity in biology; Acquire the skills to understand the methods and process that lead to exploration; Generalisation and validation of scientific knowledge in biological science; Relate biology education to environment (natural environment, artifacts and people) and appreciate the issues at the interface of science technology and society; Imbibe the values of honesty, integrity, cooperation, concern for life and preservation of environment; Solving problems of everyday life; Know the facts and principles of biology and its applications consistent with the stages of cognitive development of learners; Specific objective of different content areas in biology.

#### UNIT III: EXPLORING LEARNERS

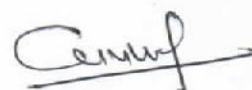
Motivating learner to bring his/her previous knowledge in science/biology gained through classroom/environment/parents and peer group. Cultivating in teacher-learner the habit of listening to child; Generating discussion, involving learners in teaching-learning process, encouraging learners to raise questions, appreciating dialogue amongst peer groups, encouraging learners to collect materials from local resources and to develop/fabricate suitable activities in biological science (individual or group work); Role of learners in negotiating and mediating learning in biology.

#### UNIT IV: SCHOOL SCIENCE CURRICULUM (BIOLOGICAL SCIENCE)

Trends in Science curriculum; Consideration in developing learner-centred curriculum in biology; Analysis of textbooks and biology syllabi of NCERT and States/UTs at upper primary, secondary and higher secondary stages; Analysis of other print and non-print materials in the area of biological science used in various states.

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## UNIT V: APPROACHES AND STRATEGIES OF LEARNING BIOLOGICAL SCIENCE

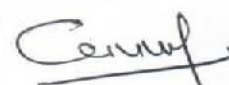
Pedagogical shift from science as fixed body of knowledge to process constructing knowledge, scientific method - observation, enquiry, hypothesis, experimentation, data collection, generalisation (teacher-educator will illustrate taking examples from different stage-specific content areas keeping in mind the variation, e.g. structure and function, molecular aspects, interaction between living and non living, biodiversity, etc.); Communication in biological sciences; Problem solving, investigatory approach, concept mapping, collaborative learning, and experiential learning in biological science (teacher-learner will design learning experiences using each of these approaches); Facilitating learners for self-study.

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1. Modern Methods of Teaching Biology. Sarup Teaching Series Sarup & Sons, New Delhi.
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11. Dr. Shoti Shivendra Chandra: Contemporary Science Teaching.
12. R.A. Yadav, Siidiqui: Teaching of Science.
13. Prof. S.K. Tyagi : Teaching of Biological Sciences.
14. Dr. A.K. Kulshrestha: Teaching of Biological Sciences.
15. All NCERT Science Text Books from class IX to XII.



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**PAPER III:****PEDAGOGY OF PHYSICAL SCIENCE****MARKS 80****Aims of the Course:****To enable the student-teacher to understand**

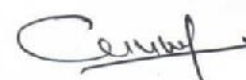
- Gain insight on the meaning and nature of physical science for determining aims and strategies of teaching-learning;
- Appreciate that science is a dynamic and expanding body of knowledge;
- Appreciate the fact that every child possesses curiosity about his/her natural surroundings;
- Identify and relate everyday experiences with learning physical science;
- Appreciate various approaches of teaching-learning of physical science;
- Understand the process of science and role of laboratory in teaching-learning situations;
- Use effectively different activities/demonstrations/laboratory experiences for teaching-learning of physical science;
- Integrate in physical science knowledge with other school subjects;
- Analyse the contents of physical science with respect to its branches, process skills, knowledge organisation and other critical issues;
- Develop process-oriented objectives based on the content themes/units;
- Identify the concepts of physical science that are alternatively conceptualised by teachers and students in general;
- Explore different ways of creating learning situations in learning different concepts of physical science
- Formulate meaningful enquiry episodes, problem-solving situations, investigatory and discovery learning projects based on upper primary, secondary and higher secondary school science/physics and chemistry
- Facilitate development of scientific attitudes in learners;
- Examine different pedagogical issues in learning physical science; and
- Construct appropriate assessment tools for evaluating learning of physical science.

**Important:** Various Concepts of Pedagogy of Physical Science listed in Units 1 to 10 (PART I & PART II) given below will be evolved around the concepts given at upper primary, secondary and higher secondary (Physics and Chemistry) Science syllabi.

**Course Outline:****UNIT I: NATURE OF SCIENCE**

Science as a domain of enquiry, as a dynamic and expanding body of knowledge; Science as a

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process of constructing knowledge; Science as interdisciplinary area of learning (Thermodynamics, Biomolecules, Surface Chemistry, etc.); Facts, concepts, principles, laws and theories—their characteristics in context of physical science (citing examples for each); Physical science for environment, health, peace, equity; Physical sciences and society; Contribution of eminent scientists—Isaac Newton, Dalton, Neils Bohr, De Broglie, J. C. Bose, C. V. Raman, Albert Einstein, etc.

## UNIT II: AIMS AND OBJECTIVES OF PHYSICAL SCIENCE

Developing scientific attitude and scientific temper, Nurture the natural curiosity, aesthetic senses and creativity in Science (secondary stage)/ Physics and Chemistry (higher secondary stage); Acquire the skills to understand the method and process of science/physical science that lead to exploration, generation and validation of knowledge in science/physical science; Relate Science/Physics and Chemistry education to the environment (natural environment, artifacts and people) and appreciate the issues at the interface of science technology and society; Imbibe the values of honesty, integrity, cooperation, concern for life and preservation of environment, Solving problems of everyday life; Know the facts and principles of science/physics and chemistry and its applications consistent with the stages of cognitive development of learners, (e.g. Mechanics, Heat, Electricity, Magnetism, Light, Acid, Bases and Salts, Thermodynamics, Metallurgy, Physical and Chemical Changes, Nature and States of Matter, etc.); Specific objective of different content areas in science/physics and chemistry.

## UNIT III: EXPLORING LEARNERS


Motivating learners to bring his/her previous knowledge gained in science/ physics and chemistry through classroom/environment/parents and peer group; Cultivating in teacher-learner the habit of listening to child; Generating discussion, involving learners in teaching-learning process; Encouraging learners to raise questions, appreciating dialogue amongst peer group; Encouraging learners to collect materials from local resources (soil, water, etc.) and to develop/fabricate suitable activities in science/ physics and chemistry (individual or group work); Role of learners in negotiating and mediating learning in science/physical science.

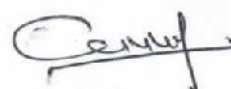
## UNIT IV: SCHOOL SCIENCE CURRICULUM (PHYSICAL SCIENCE)

Trends in Science curriculum; Consideration in developing learner-centred curriculum in physical science, Analysis of science/physics and chemistry syllabi and textbooks of NCERT and States (at upper primary, secondary and higher secondary stage); Analysis of other print and non-print materials used in various states in the area of physical science.

## UNIT V: APPROACHES AND STRATEGIES OF LEARNING PHYSICAL SCIENCE

Pedagogical shift from science as fixed body of knowledge to process of constructing knowledge, scientific method—observation, enquiry, hypothesis, experimentation, data collection, generalisation (teacher-educator will illustrate each taking examples from specific contents of science/physics and chemistry, such as Solutions, Colloids, Chemical Equilibrium, Electrochemistry, Mechanical and Thermal Properties of Matter, Reflection, Refraction, Wave Optics etc.); Communication in Science/Physical science, Problem solving, investigatory

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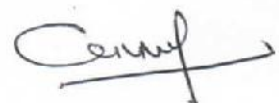


approach, concept mapping, collaborating learning and experiential learning in science/ physics and chemistry (teacher-learner will design learning experiences using each of these approaches), facilitating learners for self-study.

#### REFERENCES:

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2. New UNESCO Source Book for Science Teaching (1978), Oxford & IBH, New Delhi.
3. Sharma, R.C. & Shukla C.S.(2002): Modern Science Teaching, Dhanpat Rai, Publishing Company, New Delhi.
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5. Vaidya, N (1996): Science Teaching for the 21st Century Deep & Deep Publications, New Delhi.
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7. www.wikipedia.com Chikara, M.S. and S.Sarma(1985): Teaching of Biology, Prakash brothers, Ludhiana unter
8. Dr. Shoti Shivendra Chandra: Contemporary Science Teaching.
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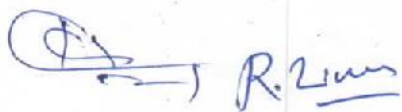
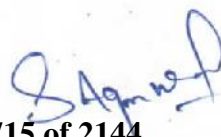
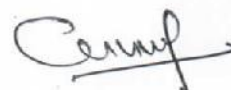
**B.ED. SYLLABUS (SEMESTER II)****PAPER IV****SOCIOLOGICAL PERSPECTIVES OF EDUCATION****MARKS 80****Aims of the Course:****To enable the student –teacher to understand**

- i. To understand the social diversity in the state and the class room and its implication for teaching
- ii. To understand and be able to use some key concepts relating to social stratification
- iii. To understand the nature of caste and changes occurring in it; to focus attention on the scheduled castes and their education
- iv. To understand the problems faced by the tribal communities and the issues in education of tribal children
- v. To understand how poverty affects schooling prospects of children with special reference to migrant children

**Course Outline:****UNIT I: Understanding diversity in Indian society with special reference to Chhattisgarh**

Diversity in Indian society, especially in Chhattisgarh, would be explored through case studies of some villages, regions or cities. Profile of different communities in terms of their ecology, economy, language, culture and educational status will be taken up for discussion. Special focus will be on childhood in these communities and access to education. Student teachers will be encouraged to look at this diversity as a potential pedagogic resource within the class room.

- i. Diversity in this class room. Getting to know the diverse socio-cultural and linguistic background of fellow students. Getting to know about how they got themselves educated
- ii. Ethnographic profiling of some five communities of the state (for example, one tribal, one scheduled caste, one artisanal community, one farming caste, one minority religious community)
- iii. Children at risk educationally – profiling communities of children who have not been integrated well into schooling (non-enrolment, early dropout, low achievement).
- iv. Profiling of the society of one's own village or town in terms of communities, professional groups, economic status, social respect, power, etc.
- v. How can a teacher use the social background of diverse students as a resource for teaching in the class room?

## UNIT II: Sociological concepts relating to social stratification

Some key sociological concepts like life opportunities, discrimination, exclusion, stratification, etc. will be discussed to enable the student teachers to use them in different social contexts.

- i. Life opportunities, class, status and power: frameworks of Marx and Max Weber
- ii. Social discrimination, exclusion and exploitation.
- iii. Social capital, cultural capital and economic capital – the approach of P. Bourdieu
- iv. Equality of opportunities and capabilities approach of Amartya Sen

## UNIT III: Aims of Education

- Aims of Education in key policy and documents:
- Mudaliar commission report
- Kothri commission report
- Curriculum frame work, 1975
- National policy on education, 1986
- Curriculum frame work, 2000 and 2005
- NCFTE 2009

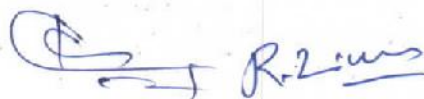
## UNIT-IV: DEMOCRACY AND EDUCATION

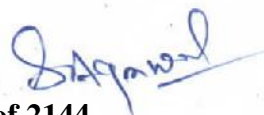
- Meaning of the term “National integration and Emotional integration” its need, role of teacher & educational institution in achieving National integration through democratic integration, explanation of cultural heritage, contributions of different religions (Hinduism, Buddhism, Sikhism, Islam, Christianity and Jainism) for the same cause and human upliftment, equal communication, philosophy of celebration of Indian festivals.
- Sociological basis of education. Relationship between individual to individual and individual to society, in terms of Norms given by the existing social order; education as liberal utilitarian, education as a tool of economic education, as an agent of Social change, education as a means of National welfare through the Immediate welfare of the society, education and human resource development.
- Meaning of a new social order, eradication of illiteracy, objectives of NAEP; provisions made and channels started for educating socially, culturally and economically deprived; Means and measures taken for equality of opportunities in terms of castes, tribes. Disabled, Gender and Minorities:

## UNIT V: The Current Concerns of Indian Education

Private public partnership (PPP); yet others relate to the status of teachers – casualization and informalisation of teachers. Student teachers will be given an opportunity to study these concerns and prospects through case studies and other academic literature:

- (i) Professional ethics
- (ii) Impact of privatization and Developments on Human Resources on the institution

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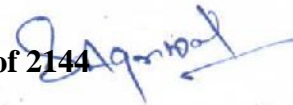
**PRACTICUM:**

1. Field based surveys of status of marginalised social groups like SC, ST, migrant workers, rural and urban poor, etc and their educational prospects.
2. Action research to understand the problems faced by children of marginalised communities in schools of different kinds.
3. Action research to understand the implementation of government schemes for education of the marginalised groups.
4. Surveys to study condition of different kinds of schools and teachers and other staff working in them.
5. Surveys to understand field realities relating to policy issues under discussion
6. Role play and dramatization of issues relating to education of marginal groups

**REFERENCES:**

1. Position Paper of Focus Group on Education of SC and STs, NCERT
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14. Sociology, NCERT Text books for class XI and XII
15. JP Naik & S Nurullah, A Students' History of Education in India, Macmillan (available in Hindi)
16. Education policy documents and Commission Reports: Mudaliar Commission, Kothari Commission, National Commission on Teachers, Yashpal Commission, National

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Policy on Education 1965, 1988 & 1992

**Films & Documentaries:**

1. Shyam Benegal, Making of the Constitution (12 parts)
2. Shyam Benegal, Bharat Ek Khoj (relevant parts on National movement)
3. India Untouched.

**PAPER V**

**LEARNER AND LEARNING PROCESS**

**MARKS 80**

**Aims of the Course:**

**To enable the student-teacher to understand**

1. Acquire knowledge and understanding of stages of human development and developmental tasks; with special reference to adolescents learners.
2. Develop understanding of process of children learning in the context of various theories of learning.
3. Understand intelligence, motivation and various types of exceptional children.
4. Develop skills for effective teaching learning process and use of psychometric assessment.

**UNIT-I**

**Nature of psychology and learners**

- Psychology: Its meaning, nature, methods and scope; functions of educational psychology.
- Stages of human development; stage specific characteristics and developmental tasks.
- Adolescence in Indian context - characteristics and problems of adolescents; their needs and aspirations.
- Guidance and counselling for adolescents.

**UNIT-II**

**Learning**

- Nature of learning; learning theories with specific reference to Piaget (Cognitive) Theory and Vigotsky's social learning.
- Factors influencing learning and teaching process: learner related; teacher related; process related and content related.

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**UNIT-III****Intelligence**

- Nature and characteristics of intelligence and its development.
- Theories of intelligence; two factor theory - Multifactor Theory (PMA) and SI Model.
- Measuring intelligence - Verbal, non-verbal and Performance tests (one, representative of group test and individual test of each),
- Creativity - definition, measurement.

**UNIT-IV****Exceptional Children**

- Concept of exceptional children - types, and characteristics of each type including Children with learning disabilities.
- Individual differences - Nature; accommodating Individual differences in the classroom. Learner centered techniques for teaching exceptional children.
- Personality- Definition, meaning and nature; development of personality; type and trait theories of personality.
- Group Dynamics. Psycho-analysis.

**UNIT-V: Socialization, Culture and Education in Indian context**

- History of Indian psychology with specific reference to religions and epics.
- Durganad Sinha's cognitive development
- Understanding diversity in Indian culture

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5. Garrett, H.E.: Statistics in Psychology and Education, Vakils, Fetter and simo Ltd. Bombay
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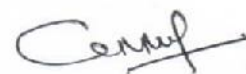
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12. Mathur, S.S.: Shiksha Manovigyan, Lyoll Book Dept Meerut
13. Srivastava, G. N. P.: Recent Trends in Educational Psychology, Psycho, Research Cell. Agra.
14. Tripathi, S. N.: Prathiba Aur Srijntmakta, Memillan Co.. Bombay.
15. Psychology in a Third world country: the Indian experience by Durganand Sinha
16. Motivation and Rural development by Durganand Sinha

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**PAPER VI - ELECTIVE (GROUP- I)**

**Note: Any one elective is to be chosen from the options.**

- (A) Educational and Mental Measurement.
- (B) Educational Technology And Management
- (C) Educational Administration and Management
- (D) Art Education

**One elective subject to be decided by considering the following-**

1. All electives must be contributing for extra capability of delivering the goods.
2. All electives should have equal difficulty level.
3. All electives should be unique in nature without being covered in any other area (of paper of B.Ed.).
4. All electives should have full bearing over the latest developments of the contemporary world.

**(VI- A) EDUCATIONAL AND MENTAL MEASUREMENT****MARKS 80**

**Aims of the Course:**

**To enable the student-teacher to understand**

1. To acquaint the student teacher with the basic scientific concepts and practices in educational and mental measurement.
2. To enable the student to tabulate and find out some standard meaning from the raw scores by using statistical procedures.
3. To develop skills and competencies in the student teacher for the use of the techniques in the field.
4. To enable the student teacher to interpret the result of educational measurement.
5. To enable the student understand about various educational and mental measurement tools.


**Course Outline:**

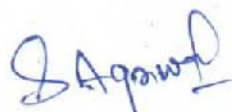
**UNIT- I**

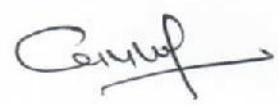
- Concept of measurement : testing and evaluation.
- Scales of measurement : nominal, ordinal, interval, and ratio scales.
- Discrete and continuous variables.
- Qualities of a test - reliability, validity and usability of a test: item analysis, procedures and item selection.

**UNIT-II**

- Educational statistics: measures of central tendency from grouped and non-grouped data.
- Measures of variability – range , quartile deviation, standard deviation.
- Graphical Representation of Data.







**UNIT- III**

- Techniques of test conduct
- Importance of establishment of rapport with the students, arranging the seats and distribution of questions for minimum pilgauge and copying; techniques for avoiding guessing in answering; objective scoring.

**UNIT- IV**

- Interpreting measurement: normal probability curve, skewness and kurtosis.
- Percentiles and percentile ranks.
- Standard scores.
- Co-efficient of correlation by Spearman's method and its interpretation.

**UNIT-V**

- Achievement tests : construction of standardized achievement tests.
- Types of test items.
- Measurement of intelligence: Concept of intelligence, Binet test, concept of IQ.
- Individual and group tests of intelligence:
- Aptitudes and personality tests: Use of aptitude tests - overview.
- Use of interest inventories.
- Assessment of personality: interview, self-report inventories, rating scale, projective techniques. (Note - Some basic concepts and items covered, under compulsory core courses have been dropped here to avoid repetition although these are relevant).

**PRACTICUM**

- Administration of a psychological test and interpretation of test results.
- Determination of reliability or validity of any self made test.
- Construction of a test battery with at least five types of test items and trying out of the same on a class/group of students.

**REFERENCE**

1. Asthana, Biptn & Agrawal, R. N. : Mapan ewam moolyankan. Vinod Pustak Mandir, Agra.
2. Asthana, Bipin and Agrawal, R. N. : Measurement and Evaluation In Psychology and Education, Vinod Pustak Mandir, Agra
3. Bhagwan, Mahesh : Shiksha mein Mapan ewam moolyannkan, Vinod Pustak Mandir Agra
4. Lindeman, R. H. annd Merenda, P.F. : Educational Measurement, Scott foreman & Company, London,
5. Rawat, D.L. : Shaikshlk Mapan ki Naveen Rooprekha, Gaya Prasad and Sons, A9ra
6. Sharma, R.A.: Measurement and Evaluation In Education and psychology, Lyall Book Depot Merrut
7. Sharma Shiksha tatha Manovigyan nain mapan. Evam moolyankan. Lyall Book Depot Merrut.
8. Verma R.S.: Shaikshik Moolyankan. Vinod Pustak Mandir. Agra.



**(VI -B) EDUCATIONAL TECHNOLOGY AND MANAGEMENT****MARKS 80****Aims of the Course:****To enable the student-teacher to understand**

1. To obtain a total perspectives of the role of technologies in modern educational practices.
2. To equip the student - teacher with his various technological applications available to him/her for improving instructional practices.
3. To help the teacher to obtain a total gender of his role of scientific management in education.
4. To provide the teacher the skills required for effective instrutional and institutional management.
5. To develop the professional skills required for guiding pupils in the three initial areas educational, penal and victual.

**Course Outline:****Unit – I: Concept of Educational Technology**

- Meaning
- Nature
- Scope
- Functions
- Need for educational technology in the schools of chhattisgarh.

**Unit – II: Communication Technology**

- Concept
- Nature
- Process
- Principles
- Componenets
- Types
- Barriers

Allied Skills Required - Micro Teaching and other skill based techniques

**Unit - III System Approach**

- Concept and characteristics
- System approach , System Analysis, System Design

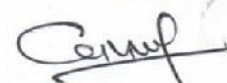
**Physical Resources of an instructional System**

- Concept
- Classification (Project/Non Project/hardware/software)

Hardware - Chalkboard, tape recorder, Educational radio, Educational Television, VCR, Instant Slide mker, OHP, Film Strip, Slide Projector, Epidiascope, Interactive Video, Computers, Reprographic Equipement.

Software - Scripts (Audio& Video), slides, Programs, lerning Materials, Film Strips,

 R. L. Singh



Transparencies, News Paper, Text Books, Maps etc.

#### Unit - IV Innovations in Educational Technology

- Video lessons and Talk Back, CAI
- Language laboratory
- Tele conferencing
- Tele-Text and Video Text
- Telephone Conferencing
- Computer Networking

**Strategies** - Tutorials, Seminar, Brain-Storming, Role-Play, discussion, Conference, Workshop

#### Unit - V Human Resources of an Educational System & Management

- Identification of the Human Resources, resources within and outside the school system

#### Meaning of Management in Education

- Managing curriculum, managing co-curriculum, Managing school discipline and Managing physical resources.
- Developing performance profiles of institutions

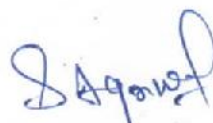
#### Assignments

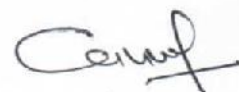
1. Tutorial/Term paper/Symposium
2. Developing Software - Transparencies/Slides/Scripts/Scenarios
3. Workshop on handling Hardware
4. Preparation of low-cost/improvised material
5. Conducting a lesson - Using OHP/Slide projector or computer

#### References:

1. Brown, J.W, Lewis Pb. 7 harclerac : AV Instructional Technology: McGraw Hills, new York.
2. Davies, I.K. The Management of Learning, McGraw hills, New York.
3. Goel, D.R, Educational T V in India - Organisation and Wilization, Unpublished post doctoral Thesis, M.S. University of Baroda.
4. Jerone, P.L & Clarence, M.W.: A Guide to programmed Instruction, J. Willey & sons, New York
5. Richmond, W. Kenneth: The concept of educational Technology , A Dialogue with yourself, London, Weldenfeld and Nicols, 1970.
6. Sharma, R.A. : Technology of Teaching , Meerut, Lyall Book Depot, 1986.
7. Singh P.: Cybernetic Approach to Teaching; The progress Education, Pune, May 1984.
8. Smith K.U : Snd smith marget, F. : Cybernetic principles of learning and Evaluation, New York, Holt, Rinehart and Winston, 1966
9. Taber J.J., Glaser F4 & Schasffer, H.N: learning and programmed Instruction, Addison Waler Reading Massachuset, 1965.
10. William D.: using Mass Media in Schools, New York, Appleton century Crops 1962.

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**(VI- C) EDUCATIONAL ADMINISTRATION & MANAGEMENT****MARKS 80****Aims of the Course:****To enable the student-teacher to understand**

1. To acquaint the student teachers with the concept and concerns of educational administration.
2. To develop an understanding of the role of the headmaster and the teacher in school management.
3. To enable the students to understand the concept and importance of communication and its possible barriers in educational administration.
4. To enable the student teacher to critically analyse the administrative scenario in relation to the functioning of the other secondary schools of the area.
5. To acquaint the student teacher with the scientific practices of educational management and keep him to apply it in work situation.

**Course Outline:****UNIT-I**

- Conceptual framework concept of educational administration.
- Concept of educational management human beings as inputs, process and products inputs.
- Nature, objectives and scope of educational administration

**UNIT-II**

- Role and functions of headmaster/teacher: Basic functions administration planning, organising directing and controlling.
- Maintenance of discipline, control management.
- Co-ordination and growth, development,
- Supervision and inspection, defects in the present supervision and inspection.
- Scope of educational supervision,
- Types of supervision.
- Providing guidance; leadership function,
- Crisis In management
- Decision making.

**UNIT-III**

- Communication in Educational Administration Role of communication in effective management and administration.




- Methods of communication.
- Barriers of communication in educational administration.
- Overcoming barriers to communication and effective communication In educational admin-istration..

#### UNIT-IV

- Management of Schools: Role of headmaster in planning of school activities, approaches to management - manpower approach, cost benefit approach, social demand approach, social justice approach.
- Involvement of other functionaries and agencies In the preparation of a plan.
- Delegation of authority and accountability.
- Role of the headmaster in monitoring, supervision and evaluation.
- Role of the headmaster in motivating the staff, in resolution of interpersonal conflicts.
- Role of the headmaster In creating resources and managing financial matters.
- Optimum use of available resources for growth and development of the school.
- Staff development programmes.
- Role of teachers in school management and administration.

#### UNIT-V

- Educational administration in the state : The administrative structure in the field of education in the state.
- Control of school education in the state - a critical analysis.
- Functions of the state government in relation to secondary and higher secondary schools.
- Functions of the board of secondary education in controlling secondary schools.
- Problems of secondary school administration in government schools.

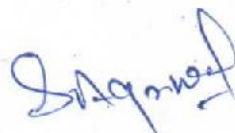
#### PRACTICUM

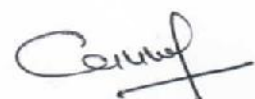
- The student-teacher is expected to conduct a study on any issue or problem relating to a school administration. The report should be in about 700 words.

#### REFERENCE

1. Bhatnagar, R.P. & Verma. I.B.: Educational Administration, Lyall Book Depot Meerut.
2. Bhatnagar, R.R & Agrawal, Vidya : Educational Administration, Supervision Planning and Financing. R. Lall nook Depot. Meerut.

 R. P. Bhatnagar

 Vidya Agrawal

 R. Lall



**(VI-D) ART EDUCATION****MARKS 80****Aims of the Course:****To enable the student-teacher to understand**

- To work together on small and large projects.
- To encourage students to free expression and creativity.
- To acquaint students with basic elements of design.
- To develop an insight towards sensibility and aesthetic appreciation.
- Joyful experience
- To develop a perspective of artistic and creative expression.

**Course Outline:****UNIT I: Art appreciation / brief history of Indian Art**

- Sculptures: (Any 2 Sculptures of every period giving brief introduction).
  - Indus valley (They must have read in this till 8th standard).
  - Mauryan Period
  - Gupta Period
  - Folk Art
  - Modern / Contemporary Art
- Paintings;
  - Ajanta and the mural traditions
  - Miniature Paintings
  - Contemporary Paintings
  - Folk Art

**UNIT II: Visual Arts.**

- History of visual arts
- The concept and meaning of visual arts
- 2D Arts, methods and techniques, Drawing, Painting, Still life, printing, life drawing, composition, collage, wall painting, posters, Alpama / Rangoli / Mandra / Folk art forms etc.
- Tribal computer Graphics: Animations
- 3-D Arts; Methods and techniques : Relief work, clay modelling, Hand poetry, molding, sculpture, Terracotta construction with mixed materials.



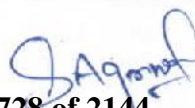

- 3-D animation. Folk / Tribal Art

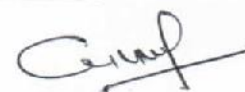
### UNIT III: Theatre.

- Sense of theoretical / dramatic self:
  - Factors of Drama; the plot, structure, characters, available material, performance space, performance etc.
  - Street plays; script writing, song writing, clowning, cartooning.
  - Issues of identity, gender, relationships, social status.
- The roots of theatre; Ritual, Festival / Celebration, Myth, Primitive Man, Language Development.
- Modern Indian Drama; Major plays and Playwrights. UNIT IV: Music and Dance:
- Laya and Swara; Basic concepts of rhythm and note.
- Sangeet; Gayan, vadan and nritya in the context of locally known songs and dances commonly performed.
- Musical Instruments; categorization.
  - ❖ Music of different geographical areas such as the desert, mountains, jungles and river-belt.
  - ❖ The term 'Nritya' or 'Naach'
    - a) Movement of different parts of the body
    - b) Expression
    - c) Literature
- Percussion instruments
- Any two regional dances
  1. Description of the region
  2. Dialect
  3. Costumes
  4. Music
  5. Tal
- Discussions on -

1.	Rajasthani Folk Dance	(ref. Tarana List CIET)
2.	Himachal Pradesh ke Lok Nritya	(ref. Tarana List CIET)
3.	Hamare Vadya Yantra Series	(ref. Tarana List CIET)
4.	Community Singing	(ref. Tarang list CIET)









5.	Song of Unity (KSSP)	(ref. Tarang list CIET)
6.	Rajasthan Folk	Langas and Manganiars
7.	Best of Carnatic	Various Instrumental
8.	Classical Dances of	(ref. Tarang List. CIET) India Series

### UNIT V: Heritage Crafts

- Introduction to the crafts traditions of India, details about the different crafts, their classifications, regional distribution etc. Each of these topics will incorporate aspects such as the Philosophy and aesthetics, Materials, processes and techniques, Environment and resource management, Social structures, Economy and marketing.
- Clay, Stone work, Metal crafts, jewelry, natural fiber weaving and textile weaving.

### Some Reference Books Suggested for Teachers:

1. Indian Sculpture - Chintaman Kar.
2. Exploring Sculpture - Jan Amdell Mills and Boon, London.
3. The Technique of Sculpture - John W. Mills, P.T. Patsford Ltd., London.
4. A History of Sculpture of the World - Shelden Cneey, Thames and Hudson, London.
5. Form and Space -Edward Their, Thames and Hudson, London 6.Sculpture and Ideas - Michael F. Andrews.
7. Modern Sculpture -Jean Selz, Heinemann, London.
8. Creative Carving ads. (Material techniques appreciation) - Dons Z. Meilach, Pritam Publishing in the format of Posters, magazine layout, illustration animation and television
9. Bharat Ki Chitrakala (Hindi) - Rai Krishna Das

### Books published by NBT

1.	Pran Nath Mago	Contemporary Art in India: A perspective
2.	Jasleem Dhamija	Indian folk Arts and Crafts
3.	Krishna Deva	Temples of North India
4.	K.R. Srinivasan	Temples of South India
5.	Alokendranath Tagore	Abhanindranath Tagore
6.	Dinkar Kaushik	Nandalal Bose
7.	Madhu Powle	Festival of Colours
8.	Badri Narayan	Find the Half Circles
9.	Ela Datta	Lines and colours
10	Upinder Singh	Discovering Indian Art
11	Mysteries of the Past;	Archeological Sites in India

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12	Niranjan Ghoshal	Name That Animal
13	Devi Prasad	Art: The Basis of Education

**Publications Division, Government of India**

1.	Vidya Daheja	Looking Again at Indian Art
2.		Panorama of Indian Painting
3.		Buddhist Sculptures and Monuments.
4.	A. Gosh	Ajanta murals
5.	Z.A. Desai	Mosques of India

NCERT: Raja Ravi Varma (Hindi)

Lalit Kala Monographs

**PAPER VII**

**CURRICULUM AND KNOWLEDGE**

**MARKS -80**

**Aims of the Course:**

**To enable the student-teacher to understand**

- To understand the nature of curriculum and its relation to syllabi, text books and class room practices
- To understand the nature of knowledge, moral values and skills
- To examine the place of work in education
- To understand the implications of constructivism for education
- To develop and apply a framework for studying curriculum documents.

**Course Outline:**

**Unit I: Curriculum, Syllabi, Text books and Class room**

- What is a curriculum? Why do we need a curriculum?

Objectives behind framing/developing a curriculum. Aims and curriculum; the relationship between the two. Relationship between these two and pedagogy. Curriculum, syllabi and textbooks: what's the relationship between these? what are implications of this for a teacher?

- The scope of curriculum:

Knowledge, values, skill, dispositions, etc. some general discussions about each.

- The context/cultural embeddedness of curriculum.

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Curriculum as a mode of transmission of culture and social norms. Diverse strands of culture and contestations and debates within them. Problems involved in questions about cultural choices and their implications for curriculum. Who defines culture? Who defines curriculum? (relate this to the discussion on negotiating diversity in aims of education.

d. Types of curriculum:

Liberal curriculum which seeks to develop understanding and perspectives, vocational curriculum which focusses on skills and is geared towards livelihood, mixed curriculum.

**Unit II: Nature of Knowledge**

- a. Introduction to discussions about knowledge: What is knowledge? Knowledge as human endeavor: Curiosity, Practice and Dialogue. The nature of human curiosity, its limits; the complex interaction between knowledge and social practice; knowledge being formed through dialogues and shared with a larger community.
- b. Nature of disciplines/subjects and forms of inquiry in each.
- c. Sociology of knowledge: privileging of certain kinds of knowledge through curriculum and its impact upon unequal learning opportunities.

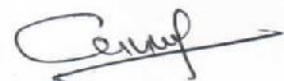
**Unit III: Moral Values**

- a. Nature of value and morality: values are what make people consider life worthwhile. Values and morality involve choices which are arrived at by balancing diverse and often contradictory values. Even so, the choice made by one person may be very different from that made by another. Most educators agree that students need to engage seriously with the task of taking moral decisions, they also agree that preaching a set of values is tantamount to indoctrination at best or promoting hypocrisy at worst.
- b. Morality in a multi-cultural, multi religious and democratic society: different cultures/religions have different value systems and preferences. Can any one of them become the basis of moral education in schools? Can there be democratic norms of dialogue between different value systems
- c. Objectives of moral education: Is it to impart information about what is valuable or to train the student how to take moral decisions or is it to instill in the student a desire to be moral person? Should investigation into why it is difficult to be moral be a part of curriculum?

**Unit IV: Curriculum and Productive Work**

- a. Understanding work as a productive activity which aims at producing tangible goods or services. Changing nature of work in recent times. Is 'work' incompatible with education?
- b. Gandhian notion of education through productive work and a review of experience of its actual implementation. Can we substitute traditional crafts with modern industrial work? From Gandhian notion to 'Socially useful productive work' (SUPW).
- c. Vocational Education: education as preparation for a particular field of employment Vs liberal education to prepare for adult life in general. Possibility of combining work skills of several fields as a part of general education.
- d. The place of work in curriculum – its role in integrating knowledge, skill and values in real

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lifelike contexts. The implication of its absence from curriculum.

#### Unit V: Frameworks for Reviewing Curriculum Documents

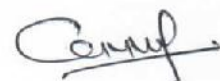
- Visioning human beings and just society.
- Visioning the role of students and teachers
- Visioning the nature of knowledge and learning
- Areas of study (subjects) and the objectives of learning them
- Visioning the role of assessment and evaluation in education
- Practicum
  - i. Conduct a collaborative knowledge construction class in a school and prepare a report on its basis. (some exemplar themes: 'let us find out about what kind of food we all eat and enjoy.' Or 'what is the nature of our family lives?' or 'what is the difference between a fly and an ant?' or let us find out the rules for use of masculine and feminine gender in Hindi language.')
  - ii. Comparative study of various curriculum documents.
  - iii. Prepare a report comparing national curriculum framework, the text books and class room practices in the school in which the student teacher has been interned. To what extent does the class room practice carry out the curricular objectives or the objectives set out in the text books?

#### REFERENCES:

1. Christopher Winch, Philosophy and Education Policy, chapter 1 & 2.
2. John Dewey, Democracy and Education
3. National Curriculum Framework NCERT 2005, (Chapter 2)
4. Position Paper, National Focus Group on Curriculum, Syllabus and Text books (NCERT, 2006)
5. Position Paper, National Focus Group on Work and Education (NCERT, 2007)
6. ज्ञान शिक्षाक्रम और शिक्षाशास्त्र, डी.एड. प्रथम एवं द्वितीय वर्ष—पठन सामग्री, एस.सी.ई.आर.टी, रायपुर 2012
7. रोहित धनकर, शिक्षा और समझ, आधार प्रकाशन, जयपुर, 2007
8. रोहित धनकर, लोकतंत्र, शिक्षा और विवेकशीलता, आधार प्रकाशन, जयपुर, 2004
9. रोहित धनकर, शिक्षा के संदर्भ, आधार प्रकाशन, जयपुर, 2007
10. Ryle, G. 'Can Virtue Be Taught?' in R. E. Dearden, P. Hirst and R. S.Peters (eds) Education and the Development of Reason, London, Routledge. (1972)
11. Straughan, R. Can We Teach Children to Be Good?, London, Allen and Unwin. (1982)

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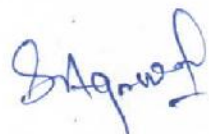


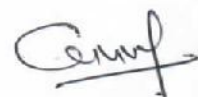




12. Kohlberg, L. The development of children's orientations toward a moral order, *Vita Humana*, (1963).
13. R Meighan, Hidden Curriculum, in Iram Siraj-Blatchford, *A Sociology of Educating*,
14. Anthony Giddens, *Sociology* (5<sup>th</sup> Edition) Cambridge 2006 (Chapter on Education)
15. Relevant sections of 1975, 1988, 2000 and 2005 curriculum documents of NCERT.
16. Christopher Winch and John Gingell. *Philosophy and Education: A Critical Introduction*. Routledge, 2005.
17. Robin Barrow. *An Introduction to Moral Philosophy and Moral Education*. Routledge, 2007.
18. Paul Hirst. "The Demands of Moral Education: Reason, Virtues and Practices." In *Education in Morality*, edited by J H Halstead and T H McLaughlin. Routledge, 1999
19. Noah Lemos. *An Introduction to the Theory of Knowledge*. Cambridge, 2007.

 R. Z. Lemos





**B.ED. SYLLABUS (SEMESTER III)****PEDAGOGY (Part II)****PAPER VIII****PEDAGOGY HINDI** हिंदी भाषा शिक्षण**MARKS 80****इकाई - 6: भाषा-साहित्य और सौंदर्य - 1**

(विभिन्न अभिव्यक्तियों भाषा की बारीकियों को जानने का सबसे अच्छा माध्यम है।)

1. सृजनात्मक भाषा के विविध रूप - साहित्य के विविध रूप को जानना, स्कूली पाठ्यक्रम में साहित्य को पढ़ना-पढ़ाना, अनुवाद कला और सौंदर्य में भाषा, स्कूली पाठ्यचर्या में मीडिया की भूमिका, उद्देश्य प्रासंगिकता, अनुवाद का महत्व और जरूरत
2. सृजनात्मक अभिव्यक्ति के रूप में हिंदी अनुवाद (अंग्रेजी और अन्य भारतीय भाषाओं के सदर्भ में) चुने हुए उदाहरण के आधार पर बताया जाएगा।

**गतिविधि/पोर्टफोलियो****प्रशिक्षण के दौरान**

- एक ही विषय पर किन्हीं तीन अखबारों के संपादकीय की भाषा पर बातचीत कर उनकी विषय प्रस्तुति को रेखांकित करें।
- एक ही अंश के तीन अनुवाद को पढ़ें और अपनी भाषा में नया अनुवाद प्रस्तुत करें
- समूह में बंट कर मीडिया लेखन के तीन अलग-अलग नमूनों (फीचर, रिपोर्ट, लेख आदि) को इकट्ठा कर उसमें समानता और अंतर को ध्यान में रखते हुए चर्चा करें।
- अखबार की किसी खबर के आधार पर संवाद लिखना।

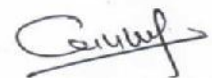
**कक्षा शिक्षण के दौरान**

- पानी से संबंधित पाठ पढ़ाने के बाद जलचक्र की जानकारी देना, पानी की बचत पर बातचीत, जल की तरल अवस्था से ठोस अवस्था का हल्का होने के कारण का पता लगाने का कार्य करवाना

**इकाई - 7: भाषा साहित्य और सौंदर्य - 2**

साहित्यिक अभिव्यक्ति के विविध रूप - कविता को पढ़ना-पढ़ाना, गद्य की विविध विधाओं को पढ़ना-पढ़ाना, नाटक को पढ़ना-पढ़ाना, समकालीन साहित्य की पढ़ाई (बाल साहित्य, दलित साहित्य, स्त्री साहित्य) हिंदी के विविध विधाओं के आधार पर गतिविधियों का निर्माण, कविता, कहानी, नाटक, निबंध, उपन्यास की पाठ विधि तैयार करना।







## गतिविधि / पोर्टफोलियो

### प्रशिक्षण के दौरान

- एक कहानी का चार अलग-अलग समूह द्वारा विश्लेषण और उसकी प्रस्तुति
- सभी विद्यार्थी किसी एक रचना की समीक्षा करें तथा एक-दूसरे की समीक्षित बिंदुओं पर कक्षा में चर्चा करें
- समूह में एक ही विषय पर अलग-अलग विद्यार्थियों की रचनाओं का संकलन और उनका तुलनात्मक विश्लेषण
- वर्तमान बाल साहित्य की समीक्षा
- अपनी मनपसंद तीन कहानियों की समीक्षा

### कक्षा शिक्षण के दौरान

- बच्चों से एक ही विषय जैसे 'बादल' पर स्वतंत्र रूप से कुछ लिखने को कहें (कोई विधा न सुझाएँ).
- रचना को जानें और कक्षा विशेष को ध्यान में रखते हुए कक्षा प्रविधि तैयार करें (किसी एक रचना को सुनकर)

(क) एक रचना अनेक स्तर अलग-अलग कक्षाओं में एक ही रचना को पढ़ाने से संबंधित)

(ख) एक रचना अनेक अर्थ (अलग-अलग नजरिये से एक ही रचना को पढ़ना)

(ग) एक रचना विभिन्न बच्चे (संदर्भ: चुनौतीपूर्ण बच्चे)

- कोई नाटक या उपन्यास पढ़वाने के बाद उसके पात्रों के रहन-सहन, बोली आदि की चर्चा कर समाज में इनमें आए बदलाव पर चर्चा करना, विभिन्न व्यवसाय तथा व्यवसाय से जुड़े लोगों, उनके कार्यों, समस्याओं पर बातचीत
- कक्षा छह हिंदी की पुस्तक में से झांसी की रानी कविता, नौकर (निबंध) पाठ के बाद -1857 के पहले, दौरान और बाद में घटी घटनाओं का टाइम लाइन (चार्ट) बनाना, गांधी जी के जीवन की महत्वपूर्ण घटनाओं का टाइम लाइन (चार्ट), गांधी जी द्वारा चलाए गए आंदोलनों का टाइम लाइन (चार्ट)

### परियोजना कार्य

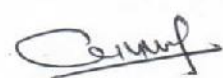
- (क) विद्यालयी अनुभव कार्यक्रम के दौरान भाषा शिक्षण को लेकर आने वाली कठिनाई पर क्रियात्मक शोध
- (ख) भाषा की कक्षा में उन अनुभवों को पिरोते हुए शिक्षण योजना बनाना स्थानीय कलाकार/कवि/लेखक से साक्षात्कार
- कक्षा 6 से 12 तक की हिंदी की पाठ्यपुस्तकों में से किसी एक कविता को चुनकर परिवेश से जोड़ते हुए उसवेफ शिक्षण बिंदु तैयार करना

### इकाई - 8: पाठ्यक्रम और पाठ्य-सामग्री का निर्माण और विश्लेषण

(पाठ्यपुस्तक शिक्षण का एक साधन है, एकमात्र साधन नहीं)

पाठ्यचर्या और पाठ्यक्रम एक पाठ्य-सामग्री अनेक - पाठ्यचर्या, पाठ्यक्रम तथा पाठ्यपुस्तकों का संबंध, पाठ्यक्रम को बच्चों के अनुरूप ढालना (शिक्षण को स्कूल के बाहरी जीवन से जोड़ते हुए तथा रटत-प्रणाली

 R. Kumar



का निषेध करते हुए सामग्री चयन, गतिविधि और अभ्यास सामग्री का निर्माण), शोधकर्ता के रूप में शिक्षक (अलग-अलग बच्चों की आवश्यकताओं को ध्यान में रखते हुए)

### गतिविधि/पोर्टफोलियो

#### प्रशिक्षण के दौरान

- नवीन पाठ्यचर्या की समीक्षा और प्रस्तुतीकरण (समूह कार्य)
  - (क) नवीन पाठ्यचर्या में भाषा शिक्षण से संबंधित अध्याय पर चर्चा
  - (ख) नवीन पाठ्यचर्या में भाषा शिक्षण से संबंधित अध्याय का विश्लेषण और प्रस्तुतीकरण (समूह)
- 'बच्चे की भाषा' या ऐसे अन्य किसी विषय पर एक संगोष्ठी आयोजित करें

#### परियोजना कार्य

- विभिन्न राज्यों के हिंदी के पाठ्यक्रम का विश्लेषण और प्रस्तुतीकरण (समूह कार्य)
- अपनी मनपसंद कहानियों का संकलन तथा उनसे संबंधित लेख
- किन्ही दो राज्यों द्वारा विकसित किसी भी एक (6 से 12) कक्षा की हिंदी की पाठ्यपुस्तक का तुलनात्मक अध्ययन

### इकाई - 9: सहायक शिक्षण सामग्री

प्रिंट मीडिया तथा अन्य पाठ्य सामग्री जैसे बच्चे द्वारा चुनी गई सामग्री, पत्रिकाएँ, अखबार, कक्षा-पुस्तकालय आदि, आई.सी.टी.-दृश्य-श्रव्य सामग्री, रेडियो, टेलीविजन फिल्में, भाषा प्रयोगशाला, सहसंज्ञानात्मक गतिविधियों की रूपरेखा (चर्चा, वादविवाद, खेल, कार्यशालाएँ, गोष्ठी आदि)

#### गतिविधि/पोर्टफोलियो प्रशिक्षण वेफ दौरान

- अपनी मनपसंद कविताओं का संकलन तथा उन पर एक लेख
- हिंदी की किन्ही दो महिला/बाल पत्रिकाओं की समीक्षा
- सीमित संसाधनों में ऑडियो/वीडियो कार्यक्रम के कक्षा में इस्तेमाल की योजना बनाना
- अपने क्षेत्र में प्रचलित लोककथा, लोकगीतों का समूह में बँटकर संकलन तैयार करना

#### कक्षा शिक्षण के दौरान

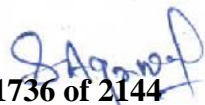
- चुनौतीपूर्ण बच्चों को ध्यान में रखते हुए दो सहायक शिक्षण सामग्री तैयार करना
- विद्यालयी अनुभव कार्यक्रम के दौरान विद्यार्थियों से हस्तलिखित पत्रिका का विकास या हस्तलिखित पत्रिका की रूपरेखा तैयार करवाना
- विद्यालयी अनुभव कार्यक्रम के दौरान विद्यार्थियों द्वारा हस्तलिखित समाचार-पत्र का विकास करवाना

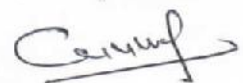
### इकाई - 10: आकलन की भूमिका और महत्व

(मूल्यांकन की भूमिका बच्चों की मौलिकता और भाषा प्रयोग में उनकी सृजनात्मकता को पैना बनाना है।)

1. भाषा विकास की प्रगति का आकलन- सतत् और समग्र मूल्यांकन, स्वमूल्यांकन, आपसी मूल्यांकन, समूह









मूल्यांकन, पोर्टफोलियो

2. प्रश्नों का स्वरूप, प्रश्नों के आधार बिंदु – समस्या समाधान संबंधी प्रश्न, सृजनात्मक चिंतन वाले प्रश्न, समालोचनात्मक चिंतन वाले प्रश्न, कल्पनाशीलता को जीवित करने वाले प्रश्न, परिवेशीय सजगता वाले प्रश्न, गतिविधि और टास्क (खुले प्रश्न, बहुविकल्पी प्रश्न)
3. फीडबैक (विद्यार्थी, अभिभावक और अध्यापक और रिपोर्ट)

गतिविधि/पोर्टफोलियो

प्रशिक्षण के दौरान

- दसवीं और बारहवीं कक्षा के किसी भी बोर्ड की परीक्षाओं के हिंदी के प्रश्नपत्रों (पिछले तीन वर्षों) की समीक्षा करें
- एक ही सवाल पर बच्चों द्वारा अलग-अलग आए जवाबों पर समूह में चर्चा करें
- कक्षा 6 से 12 तक की हिंदी की पाठ्यपुस्तकों में से ऐसे दस प्रश्न छांटे जिनमें भाषा मूल्यांकन का सृजनात्मक रवैया परिलक्षित होता है (समूह कार्य)

कक्षा शिक्षण के दौरान

(क) कक्षा छह के किसी बच्चे की प्रथम त्रैमासिक आकलन रिपोर्ट में दिए गए सुझावों का अध्ययन करना

(ख) इन सुझावों का बच्चे के भाषायी विकास में इस्तेमाल करने के लिए युक्तियों सुझाना


परियोजना कार्य

- उच्च प्राथमिक स्तर पर आकलन एवं मूल्यांकन की मौजूदा प्रक्रिया पर रिपोर्ट तैयार करें
- एन सी ई आर टी द्वारा प्रकाशित आकलन स्रोत पुस्तिका भाषा हिंदी पढ़ें तथा इसमें आए आकलन संबंधी क्रियाकलापों को कक्षा 6 से 12 के अनुरूप विकसित करते हुए एक संक्षिप्त लेख लिखें

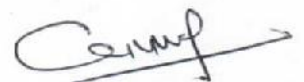
सीखने सिखाने की प्रक्रिया में अध्यापकों की भूमिका एक सहायक और मित्र की होगी। अध्यापकों के सामने यह चुनौती होगी कि वह हरेक विद्यार्थी से एक तरह की सृजनात्मक क्षमता (उनर भी) की अपेक्षा न करें)

नोट:

परियोजना कार्य, विद्यार्थी और अध्यापक के पोर्टफोलियो, गतिविधियाँ, चर्चा-परिचर्चा, प्रस्तुतियाँ, कार्यशाला, टूर (नमूने के तौर पर कुछ गतिविधियाँ इत्यादि प्रत्येक इकाई के साथ दी गई हैं। ऐसी अन्य गतिविधियाँ स्वयं भी तैयार कर सकते हैं। प्रत्येक विद्यार्थी को अपना पोर्टफोलियो तैयार करना है तथा प्रत्येक वर्ष चारपरियोजना कार्य करने अनिवार्य हैं।

 R. Z. Z. Z.

 S. S. S. S.

 C. C. C. C.

**PAPER VIII:****PEDAGOGY OF LANGUAGE (ENGLISH)****MARKS 80****Course Outline:****UNIT VI: LANGUAGE, LITERATURE AND AESTHETICS-I**

Different Creative forms of English Language: Understanding different forms of literature; Literature in the school curriculum: Needs, objectives and relevance; Role and relevance of media in school curriculum; Translation: Importance and need, Translation as a creative activity: through examples of translated texts into English from different Indian languages.

**Activities**

- Take three editorial pieces on the same topic from different newspapers. Have a discussion on their language and presentation
- Take two translations of any piece of creative writing. Read these pieces and then translate the piece yourself
- Take any creative writing related to history, e.g. Discovery of India and prepare a flow chart on the main events
- Review any story and have a discussion in groups
- Take any piece on Geography and prepare a teaching strategy for teaching any Geographical phenomena, e.g. climate change, water.

**Teaching Practice**

Take any topic of your choice and write about it in any form of creative writing.

**UNIT VII: LANGUAGE, LITERATURE AND AESTHETICS-II**

Teaching of Different Forms of English Literature: Poetry, Prose, Drama: The relative importance of Indian, classical, popular, and children's literature in English; Developing tasks and materials for study skills in English literary forms; The study of contemporary Indian, Asian, European and African literature; Lessons planning in prose, poetry and drama at various school levels.

**Activities**

- Review any two stories of your choice
- Interview any local artist/poet/writer
- Collect Indian folktales in English (translated) for your portfolio
- Prepare a newsletter on the basis of your school experience programme (hand written).

**Teaching Practice**

Take any creative writing, e.g. a poem or a story and develop teaching strategies to teach:

- (a) Same pieces for different stages; (b) Understanding any creative piece at different levels; and



(c) Teaching the same piece to children with special needs.

### Action Research

- Identify and list language (English) related errors common among students.
- Prepare a list of idioms, proverb in English
- Teaching any creative piece in the classroom on the basis of
  - (a) Level of the students
  - (b) Perspective
- Prepare an outline for action research on the basis of your experience of the difficulties faced during school experience programme.

## UNIT VIII: DEVELOPMENT AND ANALYSIS OF SYLLABUS AND TEXTUAL MATERIALS

Understanding the relationship between curriculum, syllabus and textbook; Selection of materials; Development of activities and tasks; Connecting learning to the world outside; Moving away from rote-learning to constructivism; Teacher as a researcher. (Develop meaningful strategies keeping in view the needs of the learners.)

### Activities

- Do a comparative study of one textbook of English from any class (VI to VII) developed by any two states
- Prepare an outline for the development of the textbook for the same class for your state. Project
- Prepare a collection of poems and stories of your choice.

## UNIT XI: TEACHING-LEARNING MATERIALS AND AIDS

Print media; Other reading materials. such as learner chosen texts, Magazines, News papers, Class libraries, etc., ICT- audio-visual aids including CALL programmes; Radio, T.V., Films; Planning co-curricular activities (discussion, debates, workshops, seminar etc.); Language labs, etc.


### Activities

- Prepare a list of audio-visual aids related to teaching of English and use them wherever necessary
- Identify and prepare different types of teaching aids for children with special needs (speech impaired) Organise a workshop/seminar/conference on the topic 'Language of Children' or any other related topic.

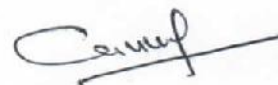
### Project

Prepare an outline for a school magazine development

- The material for the school magazine based on your experiences during school experience practice (Handwritten)
- Review contemporary children's literature
- Review any two magazines for women.







**UNIT X: ASSESSMENT-ITS ROLE AND IMPORTANCE**

- Progress and assessment of development of language; Continuous and comprehensive evaluation; Techniques of evaluation—oral, written, portfolio; Cloze test, Self evaluation; Peer evaluation; Group evaluation.
- Typology of questions; Activities and tasks (open-ended questions, MCQ, true and false etc.) reflecting—Problem solving, creative and critical thinking, Enhancing imagination and environmental awareness.
- Feedback to students, parents and teachers.

**Activities**

- Write a report on current practices of assessment and evaluation at the Upper Primary Stage
- Analyse the question papers of English language (Previous-3 Years)— Classes X and XII (any board) in the light of new approach of assessment
- Develop a question paper for upper primary and secondary stage to assess all the aspects of language learning
- Analyse answers given by the learners for one particular question
- Select any ten questions from the Class VI English textbook which lend scope to the creativity of the learners
- Study the key points of the Ist Term assessment of any student of Class VI
- Devise a strategy to incorporate the suggestions given in the Ist CCE report for the progress of the learner.

**Note**

- Project Work, Students-Teacher’s Portfolio, Activities, Presentations, Workshops and Educational tours to be carried out during both the years. (Some activities have been given in each Unit as examples. Such other activities may be developed as per the need. Every student has to prepare his/her own portfolio and four projects are compulsory for each year.)

**NOTE: Suggested readings were given at the end of part I of the course.**

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**PAPER VIII:****PEDAGOGY OF SOCIAL SCIENCES****MARKS 80****Course Outline:****UNIT VI: TEACHING-LEARNING OF HISTORY****Continuity and Change over Time and Historical Construction**

This Unit seeks to introduce student-teachers to some of the seminal issues and concepts of social change in Indian and World History. It also aims to explain how historians do History and how it ought to be done in schools. It, therefore, focuses on constructivist pedagogy in History and the general competencies that children are likely to develop through the study of History. Historical Methods

Evidence, facts, arguments, categories and perspective; Distinctions between fact and opinion and between opinion, bias and perspective; Evidence-based History teaching; Primary sources and the construction of History Thinking in terms of problems for analysis in History. Social Formations in History

Different social formations in History and the periodisation of World History; The periodisation of Indian History: Ancient, medieval, modern and contemporary societies State-formation and different types of states in History Capitalism, Select Issues of Social Change in Indian History Culture, social stratification and social change in India; Caste and class in Indian society Shared religious cultures and conflicts between religious communities in India

Gender differentials and how these cut across caste and class structures as well as religious communities. (Case Study: India)

The above content may be used to understand the teaching, learning strategies and skill development in History. Interactive, constructivist and critical pedagogies in History

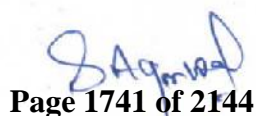
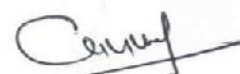
Going beyond the textbook; Getting children to craft little nuggets of History from primary sources Encouraging children to think from first principle in History.

**The Lateral Development of Different Skills**

Observation of skills relating to primary and secondary data; Observing coins, inscriptions (if available), the material remains of the past and visuals; Helping children to read passages from primary sources; Thinking about what all these sources might or might not reveal Learning to analyse critically and to argue; Observing how arguments have been made in the standard secondary sources and how these muster facts and evidences Helping children to develop oral and written expression.

**UNIT VII: TEACHING-LEARNING OF POLITICAL SCIENCE DEMOCRACY, DEVELOPMENT, AND DIVERSITY**

The Unit on Political Science deals with the broad themes of democracy, development, and



diversity. These three interrelated themes are concerned with political, economic, and social aspects of our everyday life. The contents in this unit contain key political concepts and issues. While explaining them, teachers are expected to refer to both historical and current events, processes and personalities from India and different parts of the world. They are also expected to make references to key concepts in the disciplines of Sociology, Economics, and Geography, so as to highlight the interrelationship between Political Science and these disciplines.

### What is Politics?

- ❖ Political Science: Nature and scope, key concepts, current trends Elements of State: Population, Territory, Government, and Sovereignty
- ❖ Forms of Government: Democratic (Liberal and Social), non-democratic, Rule of Law, Authority, Power, Legitimacy, Civil Society, Citizenship, Rights, separation of Powers, Organs of Government: Legislature, Executive, and Judiciary.
- ❖ Constitutional Vision for a Democratic India .The making of the Constitution of India
- ❖ Justice (with special reference to Social Justice and Empowerment) Liberty, Equality, Dignity, Socialism, Secularism (Relationship between State and Religion): Western and Indian Versions
- ❖ Fundamental Rights (Prohibition of discrimination; Rights of Dalits, Tribes, minorities [Religious/Linguistic], Women and Children, the Disabled)
- ❖ Directive Principles of State Policy (with special reference to welfare of the people) Fundamental Duties.

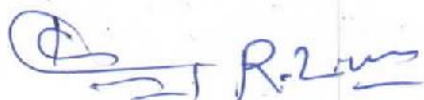
### The Working of the Government

- ❖ Structures and Functions of the Government at different levels Union, State/UT, District and Local Bodies (Panchayats and Municipalities)
- ❖ Relationship among the three organs of the Government, Relationship between the three levels of the Government, Democratic decentralisation, citizen participation.
- ❖ Society and Political Processes , Elections, political parties, pressure groups
- ❖ Social movements: Dalit movement, Tribal movement, Women's movement, environmental movement; Role of media, Role of NGOs, RTI The above content may be used to understand the teaching-learning strategies and skill development in Political Science.

### Teaching-learning Strategies

The teaching-learning process needs to take into account the lived experiences of student-teachers. The issues in this Unit can be introduced by referring to the relevant items from daily newspapers (e.g. instances of violation and protection of human rights). The contents are to be transacted through participatory methods involving all participants. 'Learning by discussing' is to be followed as a regular practice in the classroom.

Social inquiry approaches can be used in teaching, learning of Political Science. The student-teachers may be encouraged to observe actual functioning of the institutions of different local Government bodies in own district and prepare reports as group projects. They may also be encouraged to undertake field research, conduct in-depth interviews, and interpret field data and







critically understand political concepts.

Teaching-learning Materials: Constitution of India, atlas, political maps (World, Asia, India, States, Districts), globe, two daily newspapers, news magazines.

### UNIT VIII: ASSESSMENT FOR LEARNING IN SOCIAL SCIENCES

Characteristics of Assessment in Social Sciences: Types of questions best suited for examining/assessing/understanding the different aspect of Social Sciences; Questions for testing quantitative skills, Questions for testing qualitative analysis; Open-ended questions .Open-book tests: Strengths and limitations ,Evaluating answers: What to look for? Assessing projects: What to look for? Continuous and Comprehensive Evaluation (CCE) in Social Sciences.

### UNIT XI: ANALYSIS OF SOCIAL SCIENCES TEXTBOOKS AND QUESTION PAPERS

Analysing textbooks in Social Sciences in the light of the syllabus and from the perspective of the child (Textbooks of the same class may be taken up for all subjects in Social Sciences)

Analysing question papers of any State Board/CBSE and NCERT's textbooks in the light of the subject specific requirements in terms of understanding and skills.

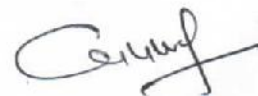
### UNIT X: INTER-DISCIPLINARITY THROUGH PROJECTS AND FIELD VISITS

- Projects in Social Sciences should be selected keeping in view the interconnections between the various disciplines that constitute Social Sciences. The interrelationship among various aspect of Social Sciences may be visualised as follows:
- Geography and Economics: Transport and communication in a region – assessing current position with reference to development needs
- History and Political Science: Socio-political systems; Women's rights in society Economics and History: Agrarian change in India; Industrialisation in India
- History and Geography: Migration of people in a particular region— nature of migration, past and present trends Political Science and Geography: Sharing resources between regions/states and nations (e.g. water)
- Economics and Political Science: Family budget and impact of change in prices of essential commodities.
- These projects are just a few examples. Similar projects may be designed by student-teachers for better understanding of various issues.

**NOTE: Suggested readings were given at the end of part I of the course.**

 R. Kumar

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**PAPER VIII:****PEDAGOGY OF MATHEMATICS****MARKS 80****Course Outline:****UNIT VI : PLANNING FOR TEACHING-LEARNING MATHEMATICS**

Organisation of concepts for teaching-learning of mathematics. Stating instructional objectives, identifying learning experiences, appropriate strategies, teaching aids (Using low-cost material – preparation of various activities, such as verification of algebraic identities, surface areas and volumes of cube, cuboids, cylinder, cone, sphere, conic sections, etc.); ICT applications; Evaluation tools and learners participation in developing instructional materials, etc.

**UNIT VII: LEARNING RESOURCES IN MATHEMATICS**

Textbooks audio-visual multimedia–Selection and designing; Using community resources for mathematics learning, pooling of learning resources in school complex/block/district level, handling hurdles in utilising resources.

**UNIT VIII: ASSESSMENT AND EVALUATION**

**Informal Creative Evaluation:** Encouraging learner to examine a variety of methods of assessment in mathematics so as to assess creativity, problem-solving and experimentation/activity performance; Appreciating evaluation through overall performance of the child; Self and peer evaluation.

**Formal Ways of Evaluation:** Variety of assessment techniques and practices Assessing Product Vs Process, Knowing Vs Doing In practice of midterm/terminal examination, practising continuous and comprehensive evaluation to test regular programmes/achievements of learner.

**Assessment Framework:**

Identifying and organising components for developing framework of question paper at different stages of learning; Framing questions based on concepts and sub concepts so as to encourage critical thinking, promote logical reasoning and to discourage mechanical manipulation and rote learning; Framing of open-ended questions providing the scope to learners to give responses in their own words; Framing of conceptual questions from simple questions.

**UNIT IX: MATHEMATICS FOR ALL**

Identifying learners strength and weaknesses; Activities enriching mathematics learning – assisting learning, supplementary text material, summer programmes, correspondence course, mathematics club, contests and fairs, designing mathematics laboratory and its effective use, recreational activities—games, puzzles and riddles in mathematics, cooperative learning ensuring equal partnership of learners with special needs, stimulating creativity and inventiveness in mathematics.

**UNIT X: PROFESSIONAL DEVELOPMENT OF MATHEMATICS TEACHERS**

Types of in-service programme for mathematics teachers; Role of mathematics teacher's association; Journals and other resource materials in mathematics education; Professional growth— participation in conferences/seminars/workshops.

**NOTE:** Suggested readings were given at the end of part I of the course.



**PAPER VIII:****PEDAGOGY OF BIOLOGICAL SCIENCE****MARKS 80****Course Outline:****UNIT VI: PLANNING FOR TEACHING-LEARNING OF BIOLOGICAL SCIENCE**

Identification and organisation of concepts for teaching-learning of biology; Determining acceptable evidences that show learners, understanding; Instructional materials required for planning teaching-learning of biological science and learners' participation in developing them; Identifying and designing teaching-learning experiences; Planning field visits, Zoo, Sea shore life, Botanical garden, etc.; Organising activities, laboratory experiences, making groups, planning ICT applications in learning biology.

**UNIT VII: LEARNING RESOURCES IN BIOLOGICAL SCIENCE**

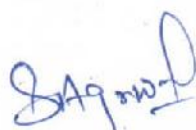
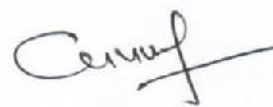
Identification and use of learning resources in biological science from immediate environmental, exploring alternative sources; Developing science kit and biological science laboratory; Designing biology laboratory; Planning and organising field observation; Collection of materials, etc.; Textbooks, audio-visual materials, multimedia-selection and designing; Use of ICT experiences in learning biological science; Using community resources for biology learning; Pooling of learning resources in school complex/block/ district level; Handling hurdles in utilisation of resources.

**UNIT VIII: TOOLS AND TECHNIQUES OF ASSESSMENT FOR LEARNING BIOLOGICAL SCIENCE**

Performance-based assessment; Developing indicators for performance assessment in biological sciences; Learners record of observations; Field diary, herbarium and collection of materials; Oral presentation of learners work in biological science, Portfolio; Assessment of project work in biology (both in the laboratory and in the field), Assessment of participation in collaborative learning; Construction of test items (open-ended and structured) in biological science and administration of tests; Developing assessment framework in biological science; Assessment of experimental work in biological science; Exploring content areas in biological science not assessed in formal examination system and their evaluation through various curricular channels; Encouraging teacher-learners to examine a variety of methods of assessments in biological science; Continuous and comprehensive evaluation.

**UNIT IX: BIOLOGICAL SCIENCE – LIFELONG LEARNING**

Nurturing natural curiosity of observation and drawing conclusion; Facilitating learning progress of learners with various needs in biology; Ensuring equal partnership of learners with special needs; Stimulating creativity and inventiveness in biology; Organising various curricular activities, such as debate, discussion, drama, poster making on issues related to science/biology; Organising events on specific day, such as Earth Day, Environment Day, etc.; Planning and organising field experiences, Science club, Science exhibition; Nurturing creative talent at local level and exploring linkage with district/state/central agencies.



## UNIT X: PROFESSIONAL DEVELOPMENT OF BIOLOGY TEACHER

Professional development programmes for science/biology teachers; Participation in seminar, conferences, online sharing membership of professional organisation; Teachers as a community of learners; Collaboration of school with colleges, universities and other institutions; Journals and other resource materials in biology education; Role of reflective practices in professional development of biology teachers; Field visits, visit to botanical garden, science park, science centre, zoo, National Laboratories etc.; Teacher as a researcher: Learning to understand how children learn science— action research in biological science.

**NOTE: Suggested readings were given at the end of Part I of the course.**

### PAPER VIII:

#### PEDAGOGY OF PHYSICAL SCIENCE

MARKS 80

#### Course Outline:

#### UNIT VI: LEARNING RESOURCES IN PHYSICAL SCIENCE

Identification and use of learning resources in physical science from immediate environment (e.g. Natural pH Indicators, Soaps and Detergents, Baking Soda, Washing Soda, Common Salts, Fruits, Fibre, Pulleys, Projectiles, Lenses and Mirrors, Interconversion of one Form of Energy to other, Propagation of waves in Solid, Liquid and Gas etc.), exploring alternative sources; Improvisation of apparatus developing science kit and laboratory in science (secondary stage), physics and chemistry (higher secondary stage); Designing laboratories, textbooks, audio-visual materials; Multimedia—selection and designing; Use of ICT experiences in learning science/physics and chemistry; Using community resources for learning science/physics and chemistry; Pooling of learning resources in school complex/block/district level, handling hurdles in utilisation of resources.

#### UNIT VII: TOOLS AND TECHNIQUES OF ASSESSMENT FOR LEARNING PHYSICAL SCIENCE

Performance-based assessment, developing indicators for performance-based assessment in science/physical science, learners' records of observations, field diary; Oral presentation of learners work, Portfolio; Assessment of project work in science/physical science; Assessment of participation in collaborative learning; Construction of test items in science/physical science and administration of tests; Developing assessment framework in science/physics and chemistry; Assessment of experimental work in science/physics and chemistry; Exploring content areas in physical science not assessed in formal examination system and their evaluation through various curricular channels; Encouraging teacher- learners to examine variety of methods of assessments in science/ physical science; Continuous and comprehensive evaluation—appreciating evaluation as ongoing teaching- learning process and through overall performance of child.

#### UNIT VIII: PLANNING FOR TEACHING-LEARNING OF PHYSICAL SCIENCE

Identification and organisation of concepts for teaching-learning of science/ physics and chemistry (on different topics, such as Motion, Work and Energy, Matter and their Measurements, Carbon and its Compounds, Periodic Properties of Elements, Atomic Structure, Dual Nature of Matter and Radiation, etc.) developing them; Identifying and designing

 R. Z. Huss





teaching-learning experiences; Organising activities, laboratory experiences, making groups; Planning ICT applications in learning science/physics and chemistry.


### UNIT IX: PHYSICAL SCIENCE–LIFELONG LEARNING

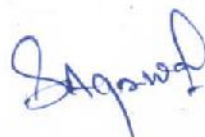
Every child has natural curiosity of observation and drawing conclusion; Identification and application of physical and chemical phenomenon in day-to-day life and human welfare, facilitating learning progress of learners with various needs in science/physics and chemistry; Ensuring equal partnership of learners with special needs; Stimulating creativity and inventiveness in science; Organising various curricular activities, such as debate, discussion, drama, poster making on issues related to science/ physics and chemistry; Organising events on specific day, such as Science Day, Environment Day, etc.; Planning and organising field experiences , Science club, Science exhibition, nurturing creative talent at local level and exploring linkage with district/state/central agencies.

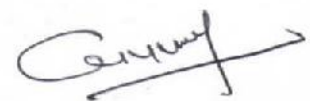
### UNIT X: PROFESSIONAL DEVELOPMENT OF SCIENCE/PHYSICS/CHEMISTRY TEACHERS

Professional development programmes for science/physics and chemistry teachers; Participation in seminar, conferences, online sharing, membership of professional organisations; Teachers as a community of learners, collaboration of schools with universities; Journals and other resource materials in science/physical science education; Role of reflective practices in professional development of physics and chemistry teachers; Field visit to industries, mines, refineries; National Laboratories, power stations, science centres; etc.; Teacher as a researcher: Learning to understand how children learn science— action research in physical science.

**NOTE: Suggested readings were given at the end of part I of the course.**

 R. Suresh





## PAPER – IX

## NAI TALIM: Skill Based Learning

MARK 80

## Aims of the Course:

**To enable the student-teacher to understand**

1. Understand the concept of local community engagement in teacher education
2. Understand the context of the child from various backgrounds & occupations.
3. Know the school education programs and policies which have local community engagement aspects.
4. Learn the process of connecting the text with the Child/learner within the local Context
5. Distinguish traditional from constructivist approaches of local community engagement
6. Train in usage of dialogic method of community engagement
7. Train in usage of organic intellectual approach for local community engagement
8. Experiential learning of best practices in community engagement
9. Participate effectively in the local community service
10. Develop insights and field realities on indignity and indigenous models.
11. Understand and practice models of Tagore, Gandhi, Shyama Prasad Mukkherji for rural reconstruction
12. Explore models of art, craft for entrepreneurship for self-reliance.
13. Understand various real, community stories of children, families.
14. Discover latent talents in the traditional occupations to promote them
15. Devise contextually suitable engagement activities.
16. Promote local occupations with literacy, technology integration and research to develop entrepreneurs

**Unit I Teacher Autonomy and Accountability**

## Meaning of Autonomy

- Freedom vs. Autonomy
- Teacher Autonomy
- Characteristics of Teacher Autonomy
- Domains of Teacher Autonomy
- Arguments for Teacher Autonomy
- Factors Affecting Teacher Autonomy
- Ways to Develop Teacher Autonomy
- How Does Teacher Autonomy Help in Enriching Learning Situations
- Meaning of Accountability
- Meaning of Accountability
- Types and Functions of Accountability

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Do Autonomy and Accountability Go Together?

**Unit II Process and Modes of Education**

- Education as an Activity or Process
- Process of Education
- Modes of Education: Informal, Formal, Non-formal, Face to Face and Distance Education
- Inclusiveness of School Education
- Need of School for all Children

**Unit III Nai Talim and Personality Development**

- Humanistic Approach to Education-  
Education for Citizenship, Character building Values and Ethics
- Work, Play, Act, Craft, Theater, Music in School Curriculum and the Basis of creativity and social harmony. Its implication to development of Head, Heart and Hands
- Context, Concern and Issues-  
Child work Vs Child Labor  
Education and alienation

**Unit IV Reflection in Curriculum and Pedagogical Practices**

- Relevance of curriculum content to the lives of Children.
- Sensitization of student on global issues i.e., resource and technology availability, Inequity, Poverty, Climate Change, Global Warming, Value Crisis, Food and Energy Crisis.
- Education in nonviolent school/classroom environment, Implication of above Issues on curriculum and pedagogy.

**Unit V Nai Talim and Field Engagement**

- Community Service and its implication
- National Integration through Nai Talim
- Nai Talim & Value Education
- Disaster Management

**Practicum**

- Field Trip

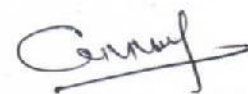
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 R. Ramos







## B.ED. SYLLABUS (SEMESTER IV)

### PAPER -X

#### GENDER, SCHOOL AND SOCIETY

MARKS 80

#### Aims of the Course:

##### To enable the student-teacher to understand

1. Understanding the role of culture (apart from biology) as determinants of gender distinction in social living
2. Awareness of factors that shape gendered roles in Indian society
3. Understand the problems of girl child education in our society
4. Developing a critical perspective on gender-based discrimination and its effects
5. To provide an introduction to and the development of an understanding of feminist approaches to the social and cultural construction of gender.
6. To develop a critical understanding of inter sectionality, including an awareness of gender and its complex intersections with other social and cultural categories, including but not limited to caste, tribe, class, sexuality and ability.
7. To equip the teacher with the ability to create more meaningful and gender just experiences for her students

#### Course Outline:

##### Unit I: Gender: Key Concepts - Social Construction of Gender

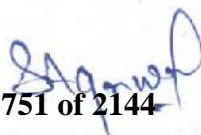
- i. Examining one's own growing up as a boy or a girl
- ii. Gender, sex, sexuality, patriarchy, masculinity and feminism
- iii. Gender bias, gender roles and stereotyping, and its consequences
- iv. Gender and other forms of inequality in relation with (caste, class, ethnicity, disability etc)
- v. Female sex ratio and child sex ratio.

##### Unit II: Gender and Schooling

- i. Schooling of girls (literacy rate, drop out rate, completion rate etc) and reasons why girls are not able to complete schooling
- ii. Why do girls feel uncomfortable in schools?
- iii. Can schools be different so that more girls can be educated?
- iv. Gender bias in curriculum, textbooks, analysis of hidden curriculum
- v. Critical examination of school and classroom processes– challenging gender biases and stereotypes
- vi. Understanding relationships within the school – child-child, teacher-child and teacher peer group relationships from the perspective of gender
- vii. Feminization of teaching profession

##### Unit III: Gender and Sexuality

- i. Understanding sexuality (sexual orientation and sexual identity – third gender) and the relationship between power and sexuality


- ii. Violence against women - empirical examples of the graded violence against women, the impact of conflict and violence on the lives of women, efforts to deal with the issue of violence against women
- iii. Legal (sexual and reproductive) rights of women

#### Unit IV: Psychological and Sociological Perspectives

- i. Radical Feminist
- ii. Socialist-Feminist
- iii. Psychoanalytical and other perspectives
- iv. Recent debates

#### Unit V: Strategies for Change

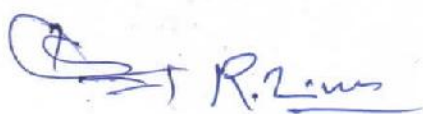
- i. Policy and management
- ii. In the school
- iii. Women's action groups
- iv. Mass media

#### Suggested themes for transaction of the content (Group discussions and review of case studies etc.)

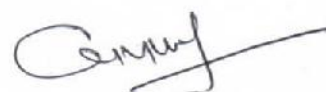
- i. Telling our own 'gendered' stories
- ii. En-culturing 'gendered' roles in upbringing within different kinds of families – case studies
- iii. Gender issues in school education – case studies
- iv. Gender issues manifest in contemporary public spaces – case studies
- v. Responding to various forms of gender discrimination

#### Suggested Readings:

1. Gender Analysis of State Policies: A case study of Chhattisgarh, Dr. Sen Ilina
2. Towards Gender Equality in Education: Progress and challenges in Asia-Pacific Region, R. Govinda, National University of Educational Planning and Administration, New Delhi.
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6. Jeffery, P. and R. Jefferey (1994) Killing My Heart's Desire: Education and Female Autonomy in Rural India. in Nita Kumar (ed.) *Women as Subjects: South Asian Histories*. New Delhi:
7. Learning, Livelihoods, and Social Mobility: Valuing Girls' Education in Central India, Peggy Froerer, Brunnel University, Anthropology and Education.

 R. Govinda

 Anita Ghai

 Nita Kumar



**PAPER -XI****ASSESSMENT IN LEARNING****MARKS 80****Aims of the Course:****To enable the student-teacher to understand**

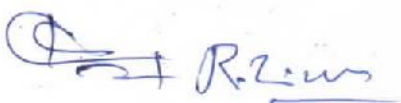
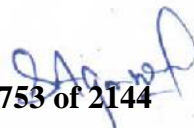
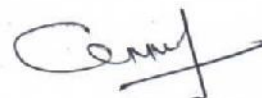
- Gain a critical understanding of issues in assessment and evaluation (from a constructivist paradigm) become cognisant of key concepts, such as formative and summative assessment, evaluation and measurement, test, examination;
- Be exposed to different kinds and forms of assessment that aid student learning;
- Become the use of a wide range of assessment tools, and learn to select and construct these appropriately; and
- Evolve realistic, comprehensive and dynamic assessment procedures that are able to keep the whole student in view;

**Course Outline****UNIT 1: OVERVIEW OF ASSESSMENT AND EVALUATION**

- Perspective on assessment and evaluation of learning in a constructivist paradigm
- Distinction between 'Assessment of Learning' and 'Assessment for Learning'
- Purposes of assessment in a 'constructivist' paradigm:
  - (i) To engage with learners' minds in order to further learning in various dimensions.
  - (ii) To promote development in cognitive, social and emotional aspects.
- Critical review of current evaluation practices and their assumptions about learning and development
- Clarifying the terms
  - (ii) Assessment, evaluation, test, examination, measurement
  - (iii) Formative and summative evaluation
  - (iv) Continuous and comprehensive assessment
  - (v) Grading.

**UNIT 2: WHAT IS TO BE ASSESSED?**

- Dimensions and levels of learning
- Retention/recall of facts and concepts; Application of specific skills
- Manipulating tools and symbols; Problem-solving; applying learning to diverse situations
- Meaning-making propensity; Abstraction of ideas from experiences; Seeing links and relationships; Inference; Analysis; Reflection

- Originality and initiative; Collaborative participation; Creativity; Flexibility
- Contexts of assessment ;Subject-related ;Person-related

### UNIT 3: ASSESSMENT OF SUBJECT-BASED LEARNING

- Enlarging notions of 'Subject-based Learning' in a constructivist perspective
- Assessment tools
- Kinds of tasks: projects, assignments, performances
- Kinds of tests and their constructions
- Observation of learning processes by self, by peers, by teacher
- Self-assessment and peer -assessment
- Constructing portfolios Quantitative and qualitative aspects of assessment: Appropriate tools for each.

### UNIT 4: TEACHER COMPETENCIES IN EVOLVING APPROPRIATE ASSESSMENT TOOLS

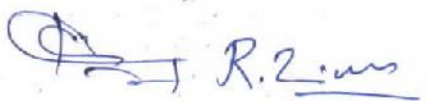
- Visualising appropriate assessment tools for specific contexts, content, and student
- Formulating tasks and questions that engage the learner and demonstrate the process of thinking; Scope for original responses
- Evolving suitable criteria for assessment
- Organising and planning for student portfolios and developing rubrics for portfolio assessment
- Using assessment feedback for furthering learning.

### UNIT 5: DATA ANALYSIS, FEEDBACK AND REPORTING

- Feedback as an essential component of formative assessment
- Use of assessment for feedback; For taking pedagogic decisions
- Types of teacher feedback (written comments, oral); Peer feedback
- Place of marks, grades and qualitative descriptions
- Developing and maintaining a comprehensive learner profile
- Purposes of reporting: To communicate
- Progress and profile of learner
- Basis for further pedagogic decisions
- Reporting a consolidated learner profile.

#### Suggested Readings:

- Asthana, Biptn & Agrawal, R. N.: Mapan ewam moolyankan. Vinod Pustak Mandir, Agra.
- Asthana, Bipin and Agrawal, R. N.: Measurement and Evaluation In Psychology and Education, Vinod Pustak Mandir, Agra
- Bhagwan, Mahesh: Shiksha mein Mapan ewam moolyannkan, Vinod Pustak Mandir, Agra
- Lindeman, R. H. annd Merenda, P.F.: Educational Measurement, Scott foreman & Company, London,
- Rawat, D.L.: Shaikshlk Mapan ki Naveen Rooprekha, Gaya Prasad and Sons, Agra
- Sharma, R. A.: Measurement and Evaluation In Education and psychology, Lyall Book Depot Merrut
- Sharma Shiksha Tatha Manovigyan nain mapan Evam moolyankan. Lyall Book Depot, Merrut.

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- Verma R.S.: Shaikshik Moolyankan. Vinod Pustak Mandir. Agra.
- CBSE Grading system

## PAPER XII

### ELECTIVE GROUP- II

**Note: Any one elective is to be chosen from the options.**

- (E) COMPUTER EDUCATION
- (F) INCLUSIVE EDUCATION
- (G) TEACHING OF VALUES

## PAPER XII (E) COMPUTER EDUCATION

MARKS 80

### Aims of the Course:

#### To enable the student-teacher to understand

1. To appreciate the role of computer education in the context of modern technological society,
2. To develop understanding of computers and their application in education,
3. To acquire sufficient knowledge of handling computers with a view to impart computers independently at school level,
4. To use computer based learning packages and organize effective classroom instructions,
5. To acquire necessary skills in using of modern word processing software,
6. To develop skills of creating and managing simple databases and handling of computers

### Course Outline:

#### UNIT – I

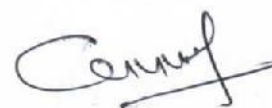
- Importance of information technology
- Classification of computers by technology, type and size.
- Uses and scope of computers
- Fundamentals of computers.
- Input/output devices,
- Central processing unit storage devices,
- Operating systems
- Application software.

#### UNIT – II

Over view of Modern Operating Systems:

- Files and folders
- Use of pointing devices
- Cut and paste
- Shortcuts to applications

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- Use and exploring the contents of storage devices- floppy disk, drives, hard discs, CD ROM etc.
- Running applications and exiting applications.

### UNIT – III

Modern word processing applications:

- Importance of word processing in education
- Characteristics of modern word processing applications
- Toolbars and menu
- Text and objects
- Text entry-Running text and paragraphs
- Formatting text- Bold, Italics, Centre and right, justification, changing font and font size, bullets and numbering.
- Editing text- select text, find and replace, cut, copy and paste.
- Editing document- Applying styles, spell check, headers and footers, footnotes, pagination, subscript and superscript.
- Insertion of objects, pictures, symbols, fields, page break and section,
- Page setup – Margins, paper size, and layout, printing and saving documents.

### UNIT – IV

Modern data base management applications:

- Importance of data base management in education,
- Characteristics of modern data base management applications,
- Concept of relational data base management system,
- Fields name, Type , Width.
- Databases,
- Forms,
- Reports.

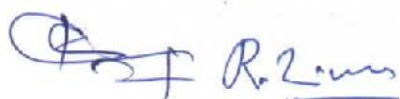
### UNIT – V

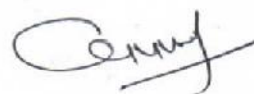
Computers for joyful learning:

- Need for joyful learning,
- Computers as an aid for joyful learning,
- Computer games,
- Multimedia capabilities of modern desk top computers,
- Internet-importance and need,
- Use of interactive and educational software.

### Assignments:

1. Write an essay on any topic using word-processing software. Document must include at least three of the following characteristics.
  - Pagination
  - Header
  - Two different paragraph styles
  - Two different fonts,
  - A picture object
  - Bullets and numbering







- Subscript and super script
  - Symbols or special characters.
2. Use relational database management software for any one of the following activities:
- Developing question bank
  - Developing a data base for either students or staff including various fields like name, date of birth, date of joining, admission, salary/grade obtained etc.
  - Automated printing of salary statement/ GPF deduction statement or any other administrative activity.

#### References :

1. Admas, D.M; Computer and Teachewr Training.
2. Bhatnagar, S.C. & Ramani,K.V; Computers and Information management.
3. CO-ROM-Titles available at cyber media 35 (4 bays) Echelon Institutional area, sector 32, Gurgaon 122002.
4. Desai, B; Database Management system.
5. Rajaram, V; Fundamentals of computers, Prentice Hall of India, new delhi.
6. SAM's Teach Yourself Office 97 in 24 hrs., Prentice Hall of India, new delhi.
7. Shelly, John and Hunt Roger; Computer studies-first course (second edition), A.H.Wheeler & Co., Delhi.
8. Windows 96: simplified. Complex publishing, New Delhi.
9. Windows 98; No experience required, BPB Publications, New Delhi.

#### PAPER XII (F) INCLUSIVE EDUCATION

MARKS 80

##### Aims of the Course:

##### To enable the student-teacher to understand

- Demonstrate knowledge of different perspectives in the area of education of children with disabilities;
- Reformulate attitudes towards children with special needs;
- Identify needs of children with diversities;
- Plan need-based programmes for all children with varied abilities in the classroom;
- Use human and material resources in the classroom;
- Use specific strategies involving skills in teaching special needs children in inclusive classrooms;
- Modify appropriate learner-friendly evaluation procedures;
- Incorporate innovative practices to respond to education of children with special needs;
- Contribute to the formulation of policy; and
- Implement laws pertaining to education of children with special needs.

##### Course Outline:

#### UNIT 1: PARADIGMS IN EDUCATION OF CHILDREN WITH SPECIAL NEEDS

- ❖ Historical perspectives and contemporary trends
- ❖ Approaches of viewing disabilities: The charity model, the bio centric model, the functional
- ❖ model and the human rights model

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- ❖ Concept of special education, integrated education and inclusive education; Philosophy of inclusive education.

## UNIT 2: LEGAL AND POLICY PERSPECTIVES

- Important International Declarations/Conventions/Proclamations – Biwako Millennium Framework (BMF, 1993-2012); Recommendations of the Salamanca Statement and Framework of Action, 1994; Educational Provisions in the UN Convention on the Rights of Persons with Disabilities (UNCRPD), 2006;
- Constitutional Provisions; The Persons with Disabilities (Equal Opportunities, Protection of Rights and Full Participation) Act, 1995 (PWD Act); The Rehabilitation Council of India Act, 1992 (RCI Act); and The National Trust for Welfare of Persons with Autism, Cerebral Palsy, Mental Retardation and Multiple Disabilities Act, 1999; RTE Act, 2009.
- National Policy – Education of Students with Disabilities in the National Policy on Education, 1968, 1986, POA(1992); Education in the National Policy on Disability, 2006.
- Programmes and Schemes of Education of Children with Disabilities: Centrally- Sponsored Scheme for Integrated Education for the Disabled Children (IEDC), 1974; PIED (1986) and District Primary Education Programme (DPEP); Scheme for Inclusive Education for the Disabled Children (IEDC, 2000), Education of Special Focus Groups under the *Sarva Shiksha Abhiyan* (SSA, 2000); Goals and Strategies in the Comprehensive Action Plan for Including Children and Youth with Disabilities in Education, MHRD, 2005, Scheme of Inclusive Education for the Disabled at Secondary School (IEDSS, 2009).
- Special Role of Institutions for the Education of Children with Disabilities Rehabilitation Council of India, National Institutes of Different Disabilities, Composite Regional Centres (CRCs), District Disability Rehabilitation Centres (DDRCs); Structures like BRCs, CRCs under SSA, National Trust and NGOs.

## UNIT 3: DEFINING SPECIAL NEEDS

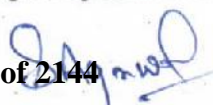
Understanding diversities—concepts, characteristics, classification of children with diversities (Visual Impairment, Hearing Impairment, Specific Learning Difficulties, Locomotor and Neuromuscular Disorders, Mental Retardation, Autism, Leprosy Cured Persons, Mental Illness and Multiple Disabilities)

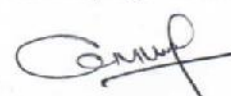
- Special needs in terms of the curriculum in the context of different disabilities and their learning styles
- Concept of an inclusive school – infrastructure and accessibility, human resources, attitudes to disability, whole school approach
- Community-based education.

## UNIT 4: INCLUSIVE PRACTICES IN CLASSROOMS FOR ALL

- School's readiness for addressing learning difficulties
- Assessment of children to know their profile
- Technological advancement and its application – ICT, adaptive and assistive devices, equipments and other technologies for different disabilities
- Classroom management and organisation
- Making learning more meaningful—Responding to special needs by developing strategies for









differentiating content, curricular adaptations, lesson planning and TLM

- Pedagogical strategies to respond to individual needs of students: Cooperative learning strategies in the classroom, peer tutoring, social learning, buddy system, reflective teaching, multisensory teaching, etc.
- Supportive services required for meeting special needs in the classroom — special teacher, speech therapist, physiotherapist, occupational therapist, and counsellor
- Development and application of learner -friendly evaluation procedures; Different provisions for examination by CBSE and the board in their State
- Documentation, record keeping and maintenance.

#### UNIT 5: DEVELOPING SUPPORT NETWORKS


- Addressing social climate of the classroom
- Child-to-child programme
- Developing partnerships in teaching: Teacher and special teacher; Teacher and co-teaching personnel; Parents as partners – developing positive relationships between school and home
- Involving community resources as source of support to teachers
- Involving external agencies for networking – setting up appropriate forms of communication with professionals and para professionals
- Liaising for reciprocal support of pre-school programmes, pre-vocational training programmes, social security, different provisions, concessions, etc.

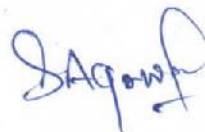
#### Books Recommended:

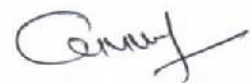
1. Bender, W.N. Learning Disability, Allyn & Bacon, Simon and Schuster, 1995, Boston London
2. Berdine, W.H & Blackhurst A.E.(eds). An Introduction to Special Education, Harpers Collins Publishers, Boston 1980.
3. Dunn., L & Bay, D.M (ed.): Exceptional Children in the Schools, New York : Holt, Rinehart, Winston.
4. Hallahar, D.P & Kauffman, J.M., Exceptional Children: Introduction to Special Education, Allyn & Bacon, Massachusetts, 1991
5. Hewett, Frank M. & Foreness Steven R., Education of Exceptional Learners, Allyn & Bacon, Massachusetts, 1984.
6. Jordan, Thomes E. The Exceptional Child, Ohio: Merrill.
7. Kirk, S.A & Gallagher J.J., Education of Exceptional Children ; Houghton Mifflin Co., Boston, 1989
8. Magnifico, L.X: Education of the Exceptional Child, New York, Longman.
9. Shanker, Udey: Exceptional Children, Jullundur: Sterling Publications.

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10. Singh, N.N and Beale, I.L. (eds.) Learning Disabilities – Nature, Theory and Treatment Spring-Verlag, New York, Inc:1992.
11. Smith, C.R, Learning Disabilities – the interaction of Learner, Task and Setting. Allyn and Bacon, Massachusetts, 1991.
12. Strange, Ruth : Exceptional Children & Youth J.J. : Prentice Hall.

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**PAPER XII (G) TEACHING OF VALUES****MARKS 80****Aims of the Course:****To enable the student-teacher to understand**

1. To understand the nature and sources of nature, and disvalues.
2. To understand the classification of values under different types.
3. To appreciate educational values like democratic, secular, and socialist.

**Course Outline:****Unit – I**

- Nature and sources of values, biological, psychological, social and ecological determinants of values – their bearing on education in varying degrees.

**Unit – II**

- Classification of values into various types, material, social, moral and spiritual values; status of values, how can these be realized through education.

**Unit – III**

- Corresponding to values there are evils or dis-values- material, social, economic, moral and religious evils leading to faithlessness and irreverence; how can education overcome these negative values.

**Unit – IV**

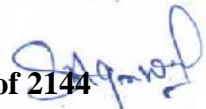
- Levels of values realization, how to resolve the conflicts among values, how to work for the intergration of values of values that are embedded in education.
- Development of values as a personal and life-long process-teaching of values as an integral part of education.

**Unit – V**

- Evaluating that teachers and other school personnel are value laden, students and parents are value laden, curriculum is value laden Evaluate.
- Value of self-sacrifice vs value of self centredness.
- Values of excellence vs values of ego-centralism.
- Values of work vs values of selfishness.
- Every teacher or all teacher need to teach values.

**Reference:**

1. Hassh, I R.H. Miller. J.R & fieding, G.D.; Models of moral Education, An Appraisal, Lorigman Inc New York.
2. Passi, B.K. & Singh, p.: Value Education, National Psychological Corporation. Agra.
3. Laths, L.E., Menu Harmins & Sydney. S.: value and Teaching, Menhill, Ohio.
4. Rocceach, M.: The Nature of human Values. Coiler McMilon Publisher, London.
5. Frank & JR. : How to teach Value: Art. Analytical Approach Prentice Hall, New Jersey.

*Pt. RaviShankar Shukla University , Raipur Bachelor of Education*

*Internship Guide*

*Description of Roles*

**Interns** are students who are a graduate in their subject major, and are spending a four month working with experienced mentor teachers on their teaching practice while taking graduate courses in the Teacher Education department.

**Mentor Teachers** are experienced school teachers who mentor interns. They provide guidance, insight and opportunities for supported practice.

**Supervisors** work with school administrators/ Mentors to determine school experience for interns, mediate in difficult situations, and oversee interns' progress in schools and with respect to program requirements. They are faculty who organize campus based lectures and seminars in each subject area. They provide supervision and guidance for the interns in and out of the campus.

*Intern Responsibilities*

Interns are students of teaching. In contrast to traditional student teaching programs, interns are not expected to begin the year ready to teach on their own. Instead, they are expected to engage in observations, co-planning and co-teaching with their mentor teachers and to build their capacity toward assuming responsibility for extended lead teaching during the semester.

Interns are in a period of transition from students to professional teachers. During this transition, they must retain the perspective of a learner as they take on the new and unfamiliar role of a teacher. Interns are expected to take an active role in their own learning and to contribute to the learning of fellow interns.

**Planning and Communication**

- Keep supervisor informed about classroom schedules and events
- Direct questions or concerns to supervisors or mentor
- Schedule observations and conferences with the mentor and inform supervisor of changes promptly
- Meet regularly with the mentor to discuss planning for instruction
- Prepare written lesson and unit plans according to both mentor teacher and supervisor's expectations
- Arrange to share all plans and materials with the mentor in a timely way, to allow for feedback before using them
- Keep the focus class binder up to date with plans and materials and ensure that it is accessible to the mentor and supervisor at all times

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- Engage in reflective diary writing or other communication forums required by mentors and/or supervisors
- Provide mentor/supervisor with copies of plans and materials
- Confer regularly with the mentor teacher and supervisor about progress and concerns

### **Professional Activities**

- Prepare for and participate in seminars
- Participate in orientation activities, faculty meetings and other school events
- Initiate introductions to school faculty, staff and administrators
- Maintain accurate contact information for mentor teacher(s) and supervisor
- In case of absence, inform everyone affected promptly, i.e. prior to the absence
- Comply with the school absence policies and have substitute teacher plans available if scheduled to teach lessons during the absence
- Comply with the internship attendance policy
- Dress professionally
- Comply with the Professional Conduct policy
- Consult mentor teacher and supervisor about the work schedule for any part time job and arrange a mutually acceptable schedule

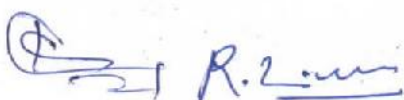
### **Personal Learning**


- Take initiative in asking questions, searching out resources, inviting feedback and creating opportunities to learn.
- Reflect on teaching and learning through discussions and assignments
- Prepare a professional portfolio (reflective diary)
- Observe teachers and students carefully, taking notes and asking questions
- Study and participate in the formation and maintenance of a classroom learning community
- Begin the year co-planning and co-teaching lessons and activities, moving toward independent planning and teaching as the year progresses

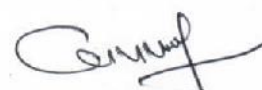
### ***Mentor Teacher Responsibilities***

#### **Planning and Communication**

- Negotiate with intern and supervisor a sequence of intern responsibilities in accordance with the program standards
- Provide intern with an outline or list of topics intern will be responsible for teaching,

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allowing extra time for intern to locate resources, plan, receive feedback from mentor teacher and supervisor, and revise

- Establish regular times to confer with the intern about unit planning and provide support for identifying big ideas and appropriate curriculum materials
- Help identify places in the curriculum where the intern can try out ideas learned in seminars
- Confer regularly with the supervisor about progress and concerns
- Participate in all school activities from morning assembly to evening assembly

### **Supporting Intern Learning**

- Facilitate and monitor intern's progress from observation to co-planning and co-teaching to lead teaching
- Guide the intern through daily school-based experiences such as working with other teachers, dealing with classes on an assembly day, etc.
- Provide appropriate, classroom-based learning opportunities throughout the year.
- Work with intern as a co-teacher as soon as possible, sharing decisions and observations
- Observe intern's teaching and help the intern think about student understanding, alternative approaches, grouping, management, etc.
- Provide interns with oral and written feedback about their teaching, including written feedback
- Reflect with the intern about teaching, student learning and ideas and strategies studied in seminars.


### **Assessment**

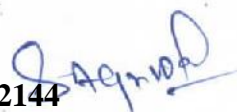
- Participate in assessment conferences
- Write and submit an Exit Performance Description at the end of the internship programme
- Help interns think about their careers as educators and assist with reviewing portfolios, videotaping, writing letters of recommendation, etc.

### **Supervisor Responsibilities**

#### **Meetings, Observation Visits, and Assessments**

- Provide copies of written assessments to interns and mentor teachers
- Conduct five feedback sessions with the intern and mentor teacher, at the appropriate point of time
- Prepare participants for sessions by explaining what to bring and topics to discuss
- Make at least five observation visits during a week

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- Prepare written assessments prior to feedback sessions, using the appropriate forms for your intern's subject area, and provide copies for the intern and mentor teacher at the conference
- Write and submit an Exit Performance Description at the end of the internship programme

### **Communication**

- Facilitate communication among interns, mentor teachers and others involved with the internship
- Communicate regularly with each intern, at least every other day
- Communicate regularly with each mentor teacher
- Communicate regularly, as scheduled, with subject area leaders about interns' progress and problems
- Provide the intern and mentor teacher with detailed notes and written feedback about observation visits
- Make sure intern and mentor clearly understand expectations and program standards
- Keep informed about program developments and pass this information on to interns and mentors promptly
- Know where to direct questions and relay answers as soon as possible

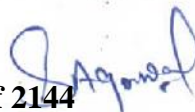
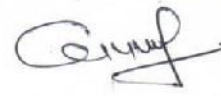
### **Support of Intern Learning by the supervisor**

- Observe the intern's teaching and confer about the planning and teaching of each observed lesson
- Provide constructive written and oral feedback for each observed lesson
- Identify the intern's specific needs and work on them with the intern and mentor teacher
- Inform subject area leader about problems promptly
- Help interns to develop their portfolios by giving feedback on materials, assisting with videotaping, etc. Records
- Keep notes of all observation visits including date, progress observed, suggestions made and actions taken
- Keep notes of all communication with interns and mentor teachers
- Keep examples of intern work indicative of progress or problems
- Keep copies of all written assessments and professional development plans
- Submit evaluation reports and professional development plans to the department head

This highlights the intern's field experience that contribute to the overall design of the internship year experience. In schools with other configurations of class time, interns and mentors should discuss with their field instructors how the intern's lead teaching time will be distributed




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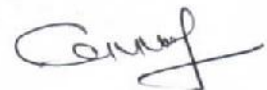



throughout the year. Key aspects of any intern's lead teaching schedule include:

- After the initial week or two of school, the intern should have lead teaching responsibility (but not sole teaching responsibility) for at least one class period in a week .
- Interns are novice teachers for whom out-of-class preparation and reflection takes longer than it does for more experienced teachers. Having regular time during the school day to plan well for their teaching and reflect carefully on it is vital for the growth of the intern's practice and for the quality of the instruction they can provide to the students they share with their mentor. Interns may spend some of this time outside the classroom, and they may spend some of it in observation and analysis of the mentor's teaching.
- In the initial internship programme, short periods of increased lead(sole) teaching responsibilities should be preceded and followed by periods during which interns return to teaching only the focus class. From each period of increased lead teaching responsibility to the next, the demands on the intern's planning, teaching, and/or assessing should increase.
- Interns' on-campus classes do not meet every week of the internship. During certain weeks, the classes do not meet so that interns can be in their placement schools all five days of the week. Interns' obligations to their courses during this time focus more on at- school or in-class activities and less on lengthy reading or writing assignments.

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Format B

**SCORE SHEET FOR REFLECTION LOG ON FOCUS LESSON***(To be filled by the trainee, based on student reflection)*

Name of the Trainee:

Duration:

Class:

Section:

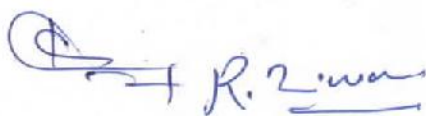
Unit of Teaching:

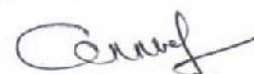
S.N.	CRITERION ON STUDENT RESPONSE	0	1	2	3	4
1	Ability to identify specific and/or varied instructional strategies.					
2	Examples to support the strategy					
3	Connectivity across disciplines					
4	Ability to identify learning styles					
5	Examples to reflect according to learning styles					
6	Ability to display personal reflections					
7	Examples reflected in support of personal reflection					
8	Group conformity					
9	Contribution to activity/ strategy					
10	Acceptance in group / solo activity or strategy					

Any other remarks by the trainee: Mentors' remarks:

Mentor's Signature

Trainee's Signature





Format C

**MENTOR'S EVALUATION REPORT OF TRAINEE**

Name of the Trainee: .....

Period of Evaluation: From: ..... to: .....

Focus Lesson No.: .....

Subject: .....

S.N.	CRITERION	0	1	2	3	4
I	<i>INSRUCTINAL STRATEGIES USED -</i>					
1.	Are appropriate for the topic/topics					
2.	Has scope for learner engagement					
3.	Has suitability of learning materials					
4.	Assess learner's understanding throughout the lesson					
5.	Has effective displays					
6.	Are consistant with the objectives					
II	<i>LEARNER'S( LEARNING STYLES) IN CLASS</i>					
7.	Identification of personalities and talents of learners					
8.	Identification of learning styles of learners					
9.	Ensuring learner participation					
10.	Identification of learner's pace					
III	<i>LEARNING ENVIRONMENT</i>					
11.	Learners are motivated, appreciated and involved.					
12.	Learners are relaxed and confident					
13.	Management of classroom					
14.	Teacher – Student relationship					
15.	Class Control					
	Overall Performance					

Strengths of the trainee:

(May use separate papers for detailed report)

Areas of Improvement:

(May use separate papers for detailed report)

Sign. of Mentor with Name



(Format D)

### Weekly Reflective Diary Format

We learn by doing and reflecting on what we do. (John Dewey)

Use this template to record your observations weekly. This document will be turned in every Monday following each week in the field. The weeks you teach will have a different format to follow. Please note that your document will be longer than one page.

Name:

Date:

Analyze your observations to identify specific teaching and learning strategies you observed involving the classroom teachers and their students. You may include your behavior if you are involved in the teaching process. Include more than one strategy.

Instructional Strategies (Include more than one strategy)	Specific example describing how the strategy was implemented

Learning Styles observed	Specific examples how the learner was supported through instructional delivery

1. What have you learned about teaching this week?
2. What have you observed/learned about students and their learning this week?

Theory base observed	Specific example from classroom to apply/support theory

**Personal Reflection:** Reflect specifically on something you observed and connect to personal opinions.

*R. L. Lewis*

*SAQ...*

*Conroy*

(Format A)

### TEACHING REFLECTIVE LOG FORMAT

(This is to be completed daily during the week you teach.)

Objectives for day:

Materials for day:

Instructional Strategies used (Explain how the strategies were implemented):

What I did well:

What my students did well:

What I didn't do so well:


What my students didn't do so well:

What I would keep the same:

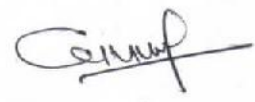
What I would Change:

What did I learn about teaching today?

(If you had to modify your lesson to help students, briefly explain here).

 R. Zivars







## Formate for Nai Talim Lesson Plan

छात्राध्यापक का नाम :- \_\_\_\_\_

शिक्षणशास्त्र :- \_\_\_\_\_

सेमेस्टर :- \_\_\_\_\_

## कार्य अनुभव पाठ योजना [नई तालिम]

## Structure of the Experiential Lesson Plan [Nai Talim]

पाठ योजना क्रं.

Date:.....

Class: ..... स्कूल का नाम.....

पाठ योजना के सोपान [Steps of Lesson Plan]

1. प्रकरण [Title of the Lesson Plan/Active Lesson Plan]

2. सामान्य उद्देश्य [General Objectives/Goals/Purpose]

A \_\_\_\_\_

B \_\_\_\_\_

C \_\_\_\_\_

D \_\_\_\_\_

E \_\_\_\_\_

3. सक्रिय उद्देश्य [Active/Specific/ Productivity Objectives [Role of H3]  
मस्तिष्क [Head]-

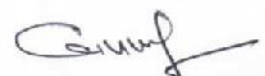
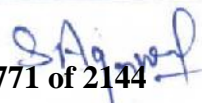
हृदय [Heart]-

हाथ [Hand]-



R.2. Kumar

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## 4. पूर्व ज्ञान [Previous Mind/Knowledge/Memory]

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## 5. शिक्षक की तैयारी [Teacher's Preparation]

शिक्षण सामग्री [Resources/Material]

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शिक्षण विधि [Teaching Method] (A)

शिक्षण प्रविधि [Teaching Technique] (A)

(B)

शिक्षण सूत्र [Teaching Maxim] (A)

(B)

पाठ योजना कहाँ करवाया जाना है [Field/Community/Working Place]

Field  Community  School Campus 

## 6. प्रस्तावना [Introduction]

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## 7. उद्देश्य कथन [Statement of the Aim]

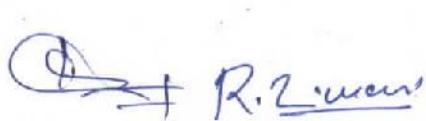
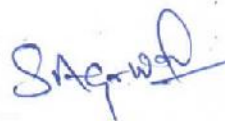
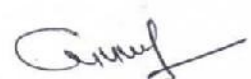
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## 8. प्रस्तुतीकरण [Presentation/Classroom Activity]

महत्वपूर्ण गतिविधियां [Performing Activity/key Activity]	शिक्षक कार्य Teachers [Role/Instructional Area]	छात्र कार्य [Students Role/Activity Phase]	अधिगम के परिणाम [Learning Outcome/Panel Board/Field]



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9. पुनरावृत्ति [Recapitulation]

क्र.	छात्राध्यापक का कार्य	छात्र कार्य

10. अनुप्रयोग/ दत्त कार्य/ परियोजना कार्य [Application/Assignment/Project Work]

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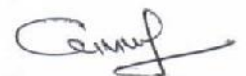
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11. आकलन एवं मूल्यांकन [Assessment and Evaluation]

A. विकास मस्तिष्क, हृदय ,हाथ [Development of H3 [Head + Heart + Hand]

मस्तिष्क (Head) -

 R. Z. Mans



हृदय (Heart) -

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हाथ (Hand) -

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B. सीखने के परिणामस्वरूप परिणाम [Learning cum Productive Outcome]

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पर्यवेक्षक का हस्ताक्षर

छात्राध्यापक का हस्ताक्षर

 R. L. Wani

 S. Agnew

 S. Agnew



**SCHEME OF ASSESSMENT**  
**M.Ed. Two Years Course, Session 2019-2021**

S.NO.	PAPER	EXTERNAL	INTERNAL THEORY/PRACTICUM
<b>SEMESTER I</b>	<b>THEORY</b>		
Paper 1	Philosophical Perspectives of Education	80	20
Paper 2	Sociological Perspectives of Education	80	20
Paper 3	Education Technology/ Teacher Education	80	20
Paper 4	Strengthening Language Proficiency	100	
	<b>PRACTICUM</b>		
	Exploring Library Resources		50
<b>SEMESTER II</b>	<b>THEORY</b>		
Paper 5	Introduction of Research Methodology in Education	80	20
Paper 6	Psychological Perspectives of Education	80	20
Paper 7	Specialization part I	80	20
	<b>PRACTICUM</b>		
	Proposal of Dissertation	100	
	Internship , School based Activities		50
<b>SEMESTER III</b>	<b>THEORY</b>		
Paper 8	History and Development of Education in India	80	20
Paper 9	Economic and Political perspectives of Education	80	20
Paper 10	Advanced Education Statistics/Education Administration	80	20
Paper 11	Gender Perspectives in Education	80	20
	<b>PRACTICUM</b>		
	Psycho-metric assessment		50
<b>SEMESTER IV</b>	<b>THEORY</b>		
Paper 12	Curriculum Development	80	20
Paper 13	Specialization Part II	80	20
	<b>PRACTICUM</b>		
	Academic Writing		50
	Dissertation	100	
	Viva Voce on Dissertation	100	
	<b>TOTAL</b>	1360	240 + 200 = 440
	<b>GRAND TOTAL</b>		1800

## PSYCHOLOGY-PRACTICUM


1. Intelligence Test
2. Achievement test
3. Mental fatigue
4. Physical fatigue by Ergo graph
5. Learning by Substitution
6. Personality Testing
7. Span of attention by Tachistoscope
8. Transfer of Learning by mirror drawing

(Any 5 practical are to be conducted)



R. L. Wani

Census





## CURRICULUM FRAMEWORK

### M.ED. TWO YEARS COURSE 2019-2021

Curriculum Organization based on NCTE framework						
Semester I	Semester II	P	Semester III	P	Semester IV	PEC
(C) Philosophical Perspectives of Education (4 Credits)	(C) Introduction to Research Methodology in Education (4 Credits)	Proposal Presentation on Dissertation (2 Credits)	(C) History and Development of Education in India (4 Credits)	Psycho-Metric Testing (4 Credits)	(C) Curriculum Development (4 Credits)	Academic Writing (2 Credits)
(C) Sociological Perspectives of Education (4 Credits)	(C) Psychological Perspectives of Education (4 Credits)	Internship School based Activities (4 Credits)	(C) Economic & Political Perspectives of Education (4 Credits)		(S) Educational Guidance & Counseling / Education for Differently Abled (4 Credits)	
(E) Education Technology / Teacher Education (4 Credits)	(S) Educational Guidance & Counseling (4 Credits) / Education for Differently Abled (4 Credits)		(E) Advanced Education Statistics / Educational Administration and Management (4 Credits)		Dissertation & Viva-Voce (8 Credits)	
			(C) Gender Perspectives in Education (4 Credits)			
12	12	6	16	4	16	2
20	18	18	20	18	18	2
C = Core paper, E = Elective Paper, S = Specialization, PEC = Professional Enhancement Course, P = Practicum						



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## M.ED. TWO YEARS COURSE (2019-2021)

### CORE STUDY (SEMESTER I)

#### PAPER I- PHILOSOPHICAL PERSPECTIVES OF EDUCATION

##### Objectives of the course:

- (i) To develop understanding of the interrelationship between Philosophy and Education
- (ii) To develop appreciation of the basic tenets, principles and developments of the major Indian Schools of Philosophy and Educational thoughts of Indian Philosophers.
- (iii) To develop the appreciation of the basic tenets principles and development of the major Western Schools of Philosophy.
- (iv) To acquire knowledge of human values and role of education.
- (v) To develop the understanding of interrelationship between Sociology and Education.
- (vi) To develop appreciation of education as a means of social reconstruction
- (vii) To understand the bearing of various Political & religious ideologies on Education.

##### UNIT-1: Philosophical Foundation of Education

- 1.1 Philosophy of Education.
- 1.2 Nature and Functions of Philosophy of Education.
- 1.3 Interrelationship between philosophy & Education..
- 1.4 Modern Concept of Philosophy: Analysis – Logical empiricism & positive relativism.
- 1.5 Scope- Functions of Educational Philosophy.

##### UNIT-2: Indian Schools of Philosophy

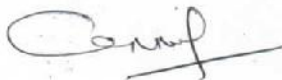
- 2.1 Sankhya, Nyaya, Vedic, Buddhist, Jainism, Islamic Traditions.
- 2.2 Education Implications of these schools with special reference to the concept of Knowledge, reality & values, methodology, public- Teacher. Relationship, freedom & discipline, Basic Tenets, aims, & objectives, curriculum.
- 2.3 Contributions of Vivekanand, Tagore, Gandhiji, Dr. Ambedkar & J.P.Naik, J.Krishnamurthi, Dr. Radhakrishnan, Arbindo to educational thinking.

##### UNIT-3: Western Schools of Philosophy

- 3.1 Idealism, Naturalism, pragmatism, realism, Existentialism, Marxism with.
- 3.2 Educational implications of these schools with special reference to basic tenets, Aims, & objectives curriculum methodology, Teacher. Pupil relationship, freedom & discipline.



R. L. Meena





3.3 Contribution of Plato, Rousseau, Dewey.

**UNIT-4: Axiology & Education**

4.1 Meaning of values

4.2 Types of various- spiritual, moral, social, aesthetic values

4.3 Values as mentioned in different schools of philosophy and their educational implications

4.4 Professional ethics of teachers.

**UNIT-5: Critical Analysis of educational thoughts:** With reference to-

5.1 Concept of man and the process of development

5.2 Epistemological perspectives of different thoughts.

5.3 Schools of Indian and western thought.

**Reference Books:**

1. The Philosophical and Sociological foundations of Education (Doaba House, Book-sellers and Publishers, Delhi-110006) by Kamla Bhatia and Baldev Bhatia
2. Groundwork of Theory of Education – by Ross
3. Modern Philosophy of Education – by Brubacher
4. Foundations of Education – V.P. Bokil
5. Anand C.L. et.al. : Teacher and Education in Emerging India, NCERT, New Delhi.
6. Anant Padmnabhan : Population Education in Classrooms, NCERT, New Delhi.
7. Bhatnagar, S. : Adhunik Bhartiya Shiksha Aur Uski Samasyayen, Lyall Book Depot, Meerut.
8. Chakravorty M. : Gandhian Dimension in Education Daya Publishing House New Delhi.
9. Mani R.S. : Educational ideas and ideals of Gandhi and Tagore, New Book Society, New Delhi.
10. Ministry of Human Resource Development: National Policy on Education, 1896, New Delhi.
11. Mohanty Jagannath: Indian Education in Emerging Society, Sterling Publication, New Delhi.
12. Pandey, Shyam Swaroop: Shiksha ki Darshanik evam Samajik Shastriya Pursht Bcomi Vinod Pustak Mandir, Agra.
13. Pathak and Tyagi : Shiksha ke Samnya Siddhant, Vinod Pustak Mandir, Agra.
14. Pathak, RD. and Tyagi, I.S.D. Shiksha ke Samariya Siddhant. Vinod Pust8tk Mandir, Agra.



R. L. ...



15. Saxena, N.R. Swaroop Shksha Re Samanya Siddhant, Lyall Book Depot, Meerut.
16. Singh B.P. : Alms of Education in India, Ajanta Publication New, Delhi.
17. Agrawal, J.C.: Nai Shiksha Niti. Prabhat Prakashan, Delhi.
18. Bhatnagar, R.P. Technology of Teaching, International Publishing House, Meerut.
19. Bhatnagar. R.R & Agarwal, Vidya Shaikshlk Prashasan, Eagle Books.
20. Bhatnagar, Suresh Shiksha Ki Samasyaen, Lyall Book Depot, Meerut.
21. Bhooshan, Shailendra & Anil Kumar : Shikshan Taknik. Vinod Pustak Mandir, Agra.
22. Manav Sansadhan Vikas mantralaya: Rashtriy Shiksha Niti 1986. New Delhi.
23. Safaya. Raghunath,. School Sangathan, Dhanpat Ram & Sons, Delhi.
24. Sampath, K. : Introduction to Educational Technology, Sterling Publishers, New Delhi.
25. Saxena, N.R. Swaroop, Shikshan Kala Ewam Paddatiyan. Lyall Book Depot, Meerut.
26. Sharma & Sharma Secondary Education and teacher Functions, Radha Publisher Mandir, Agra.
27. Higher Education in India ; Albach



R. L. Wani





**CORE STUDY (SEMESTER I)**

**PAPER II : SOCIOLOGICAL PERSPECTIVES OF EDUCATION.**

**UNIT-1: Sociology & Education**

- 1.1 Meaning & Nature of Educational Sociology
- 1.2 Interrelationship between Education and Social Variables
  - (i) Sociology of Education
  - (ii) Political Education – Process of Socialization
  - (iii) Education and Family
  - (iv) Education and Schooling
  - (v) Education and culture in general
  - (vi) Education and religion, Caste, Gender, Class
  - (vii) Education for Weaker Sections
  - (viii) Education and Development
  - (ix) Sex Education
  - (x) Economics of Education
  - (xi) Education and Constitution

**UNIT-2: Education and Socialization**

- 2.1 Process of Socialization
- 2.2 Social Stratification and education
- 2.3 Social Mobility and Education

**UNIT- 3 Education as a means of social changes**

- 3.1 Education for emotional AND SOCIAL INTEGRATION
- 3.2 Education for Nationalism and International understanding
- 3.3 Meaning and need of Equality of Education opportunity and Social Justice with special reference to caste, class, race and religion.
- 3.4 Education of Socially, Economically under-developed society.

**UNIT-4: Social forces and education**

- 4.1 Education for maintaining the peace in diverse religious beliefs.
- 4.2 World problems and terrorism – its causes, its impact on Society and remedies through Education.



R. L. ...



- 4.3 Concept of Secularism in India and World prospect and building of Secularism through Education

**UNIT-5: Political Ideologies and Education**

- 5.1 Totalitarian: Meaning, Main features, aims of Education, curriculum, Methods of teaching and School administration.
- 5.2 Democracy: Meaning, Values, Main features of democratic Education, aims, curriculum methods of teaching and School administration.

**Practical Work (any one)**

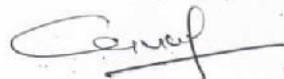
- (i) Study of the comparison between one western school with one Indian school of philosophy.
- (ii) Case Study of economically under developed student.
- (iii) Study of the impact of modern Technology in one secondary school.

**Reference books:**

1. A Sociological Approach to Indian Education (Vinod Pustak mandir, Agra 2, by S.S. Mathur)
2. The Philosophical and Sociological foundations of Education (Doaba House, Book-sellers and Publishers, Delhi-110006) by Kamla Bhatia and Baldev Bhatia
3. Groundwork of Theory of Education – by Ross
4. Modern Philosophy of Education – by Brubacher
5. Foundations of Education – V.P. Bokil
6. Educational Sociology – Brown
7. De Schooling Society- Evan Illich.



R. Kumar





## ELECTIVE COURSE ( SEMESTER I )

### PAPER III ( A ) - EDUCATIONAL TECHNOLOGY

#### OBJECTIVES :

- 1) To enable the learner to become effective user of technology in Education
- 2) To acquaint the learner with the challenges and opportunities emerging in integrating new technology in Educational process.
- 3) To make the student familiar with new trends, techniques in education along with e learning.
- 4) To enable the student to become good practioner of Educational technology and e-learning.

#### UNIT – 1: Meaning & Scope of Educational Technology

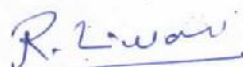
- 1.1 Educational Technology as system approach to educator.
- 1.2 System approach in educational technology and its characteristics.
- 1.3 Components of Educational technology software and hardware.
- 1.4 Modalities of Teaching
- 1.5 Difference between teaching and Instruction, conditioning & training
- 1.6 Stages of teaching pre – active, interactive and post – active.
- 1.7 Teaching at different levels one way, understanding and reflective.
- 1.8 Modification of teaching behavior microteaching, Flander;s interaction analysis simulation.

#### UNIT – 2: Communication Modes in education

- 2.1 Concepts and process of communication
- 2.2 Principals of communications
- 2.3 Communication and learning
- 2.4 Modes of communication:
  - Speaking and listing < --- > Writing and reading < ---- > visualizing and observing
- 2.5 SMCR model of communication, Sharon's model of communication
- 2.6 Task analysis

#### UNIT – 3: Integrating Multimedia in education

- 3.1 Multimedia concept and meaning text, graphics, animation, audio, video



### 3.2 Multimedia applications

- Computer based training
- Electronic books and references
- Multimedia application for educationist
- Information kiosks
- Multimedia www and web based training

### UNIT - 4: Educational software applications

- Computer assisted instruction
- Drill & practice software
- Educational simulations
- Integrated learning system
- Curriculum specific Educational software

### UNIT - 5: e-learning

- 5.1 E-learning definitions, scope, trends, attributes & opportunities.
- 5.2 Pedagogical designs & e-learning
- 5.3 Assessments, feedback and e-moderation
- 5.4 e-learning on line learning management
- 5.5 On line learning management system
- 5.6 Digital learning objects
- 5.7 Online learning course development models
- 5.8 Management and implementation of e-learning

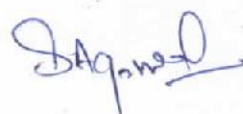
### Reference Books:

1. Integrating Technology in the classroom shelly, cashman, gunter and gunter, publication by Thomson course technology
2. Essentials of Educational Technology, Madan Lal, Anmol Publications
3. Online Teaching Tools and Methods, Mahesh Varma, Murari Lal & Sons
4. Education and Communication for development, O. P. Dahama, O. P. Bhatnagar, Oxford IBH Publishing company, New Delhi



R. Zivan

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5. Information and Communication Technology, N. Sareen, Anmol Publication
6. Communication and Education, D. N. Dasgupta, Pointer Publishers
7. e-learning a Guidebook of principals, Procedures and practices, Son Naidu, Commonwealth of Learning, Commonwealth Educational Media Centre for Asia
8. Education and Communication, O. P. Dham



R. L. Wani



## ELECTIVE COURSE ( SEMESTER I )

### PAPER III (B): TEACHER EDUCATION

#### Objectives:

To enable the students

- (1) To understand the concept of teacher Education
- (2) To develop necessary skills
- (3) To develop insight into the problems of teacher Education at different levels.
- (4) To develop experimental attitude in teacher Education
- (5) To understand new trends, and techniques in teacher Education.

#### SECTION – 1

##### UNIT - 1: Historical development of teacher Education in India

- 1.1 Historical development of Teacher Education
- 1.2 Teacher education as distinguished from teacher training.
- 1.3 The need and importance of Teacher Education
- 1.4 Concept and structure of teacher Education
- 1.5 Meaning, Nature, Scope of Teacher education
- 1.6 Aims and Objectives of teacher Education at different level
- 1.7 Need for pre-service and in service professional education of teachers at different levels in the present Indian situations.
- 1.8 Qualifications of teachers-pre-primary, primary, Secondary, Higher Secondary, Higher Education.
- 1.9 Training of special teacher-Arts, Crafts, Physical Education, Home Science, Vocational Technical and work experience.

##### UNIT – 2: Content of Teacher Education

- 2.1 (i) Theory of teacher education and its duration.
  - (ii) Practical activities to be conducted during the training Course
  - (iii) Relationship and weightage given to theory and practical work.
  - (iv) Evaluation – Internal and external
- 2.2 Instructional Methods in Teacher Education
  - i. Lecture and discussion
  - ii. Seminars



- iii. Work shops
  - iv. Symposium
  - v. Group Discussion
  - vi. Supervised study
  - vii. New Methods- Microteaching, Macro-teaching, programme learning, Models of teaching, Content-cum methodology approach.
  - viii. Virtual and e-mode
- 2.3 Practice teaching in Teacher Education.
- i. Demonstrations
  - ii. Experimentation
  - iii. Practice teaching and observations
  - iv. Significance and Supervision of Practice teaching
  - v. Internship
  - vi. Relationship of College of Education with Co-operating Schools

### **UNIT-3: Evaluation procedures in Teacher Education**

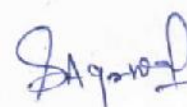
- 3.1 Assessment
- (I) Aspect of Internal & External Assessment
  - (II) New techniques of Evaluation
- 3.2 Teaching as a profession:
- 3.3 Recommendations of various commissions on Teacher Education: Kothari Commission, National policy on Education, NCTE policy.
- 3.4 Professional organizations for various levels of teacher-types and their role & functions
- 3.5 Performance appraisal of teacher
- 3.6 Code of conduct and ethics of teaching profession.
- 3.7 Faculty improvement programme for teacher Education.

### **UNIT-4: Research and Teacher Education**

- 4.1 Need of Research in Teacher Education
- 4.2 Action Research for quality improvement in T.E.
- 4.3 Area of Research in T.E.-Teaching Effectiveness, Criteria of admission, Modification of Teacher behavior, School effectiveness.
- 4.4 Current problems of Teacher Education



R. L. Rawar



- 4.5 Teacher Education and practicing schools
- 4.6 Teacher Education and UGC, NCTE, University.
- 4.7 Preparing teacher for special school
- 4.8 Preparing teacher for Inclusive classroom.
- 4.9 Integrating Technology in Teacher Education.

**UNIT- 5: Types of Teacher Education Programmes and Agencies:**

- 5.1 In-service T.E. - Concept, Meaning, Need and nature
- 5.2 Preserves T.E. - Concept, Meaning, Need and nature
- 5.3 Orientation and Refresher courses
- 5.4 Agencies of T.E.-UGC, NCTERT, SCERT, Colleges of T. E., Open University. Academic Staff colleges, University Department of Education and Teacher Organization.

**Reference Books:**

1. Sualemeyarl indsey – working with student, Teachers, Eurasla Publishing House (Pvt.) Ltd., New Delhi-55.
2. William Taylor – Society and the Education of Teachers, Faber 7 Faber
3. Dr. G. Chaurasia- New Era in Teacher Education, Sterling Publishing Pvt.,Ltd.
4. Edited by S.N. Mukarji – Education of Teachers in India, Valun 1 e I& II – S Chand & Co., Delhi
5. K.L. Shrimali-Better Teacher Education. Ministry of education, Government of India
6. Dr. S. S. Dikshit- Teacher education in modern Democracies- Sterling Publishers Pvt., Ltd., Delhi-G
7. Report of the study Group on the Education of Secondary Teachers in India Association of Training College.



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PROFESSIONAL ENHANCEMENT COURSE ( SEMESTER I )

PAPER IV: STRENGTHENING LANGUAGE PROFICIENCY

एम.एड. सेमेस्टर I

विषय— हिन्दी प्रावीण्यता

अंक—50

यूनिट – 1 भाषा विज्ञान

(Weightage – 2questions 5 marks each)

- ❖ अर्थ, क्षेत्र एवं अवधारणा
- ❖ भाषायी सृजनात्मकता – अलंकार, रस
- ❖ संवाद लेखन
- ❖ विवरणात्मक लेखन— चित्र वर्णन, यात्रा वर्णन, त्योहार, आत्मकथा, इत्यादि

यूनिट – 2 शब्द भण्डार

(Weightage 5 Questions 3 marks)

- ❖ शब्द निर्माण – उपसर्ग, प्रत्यय
- ❖ शब्दकोष का विकास, उपयोग
- ❖ क्रिया भेद
- ❖ विशेषण व क्रिया विशेषण
- ❖ चिन्ह विन्यास, महत्व व उपयोग

यूनिट – 3 व्यवहारिक व्याकरण

(Weightage 25 Questions 1 marks each)

- ❖ सन्धि – प्रकार व नियम
- ❖ वाक्यभेद— रचना के आधार पर
- ❖ अनेकार्थी शब्द
- ❖ मुहावरे और लोकोक्तियाँ
- ❖ स्वर विज्ञान (ध्वनि पर आधारित)

R. L. Rawar

## Semester – I [M.Ed.]

### Language Proficiency [English Language]

[50 Marks]

#### Unit –I [Linguistics]

(Weightage – 2 questions 5 marks each)

- ❖ Linguistics : Meaning Scope and Concept
- ❖ Creativity in language : Beautification of language use of simile and metaphor, Rhyme and Rhythm
- ❖ Descriptive writing: Picture Scene, Park, Festival, Journey, College Function, Biography etc.

#### Unit –II [Vocabulary]

(Weightage 5 Questions 3 marks)

- ❖ Development of vocabulary
- ❖ Dictionary : Use of Dictionary, Difference between dictionary and thesaurus
- ❖ Use of vocabulary in noun verb, adjective, etc.
- ❖ Use and importance of punctuation in text
- ❖ Paragraph writing

#### Unit –III [Grammar]

(Weightage 25 Questions 1 marks each)

- ❖ Use of Vowels : Vowel blends usage of C-V-C (Consonant-Vowel-Consonant) in words
- ❖ Grammar rules : R rule , W rule
- ❖ Phonetics : S sound, G sound
- ❖ Diphthong and Digraph
- ❖ Parts of sentences



R. L. Law





## PROFESSIONAL ENHANCEMENT COURSE - SEMESTER I

### EXPLORING LIBRARY AND OTHER LEARNING RESOURCES ( PRACTICUM )

#### Objectives:

Student-teachers are expected to take some initiative in pursuing interests outside the formal course work from a range of available resources. Some of these resources are as follows:

- The institute library
- Websites on the internet
- Local events and facilities, as well as local issues (in the neighbourhood or town)
- Members of local community
- Visiting resource persons.

This component is aimed at developing a sense of initiative, imagination and discernment of learning potential of the resources available in their surroundings.

#### Course Outline

##### UNIT 1

Knowing your library, Layout of the Library

Library Policies

Library Procedures – cataloguing, locating a book/material in the library.

Library Management

##### UNIT 2

Library as a resource of learning, pleasure and concentration.

School library as an intellectual space for students and teachers.

##### UNIT 3

Types of books and other material used by different readers.

Techniques of keeping these books and materials

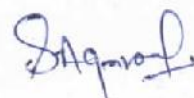
Dimensions of setting up of a school library.

##### UNIT 4

Locating information and using it for one's own career development. Resources helpful in providing information for career development: newspaper, magazines, websites, learning guides, members of local community, resource persons.



Handwritten signature: R. L. ...



## CORE PAPER ( SEMESTER II )

### PAPER V: INTRODUCTION TO RESEARCH METHODOLOGY IN EDUCATION.

#### OBJECTIVES:

To enable the students to

- (1) To understand the concept of research and educational research.
- (2) To understand the types and methods of educational research,
- (3) To understand the steps involved in educational research,
- (4) To understand the use of different tools and techniques in educational research
- (5) To use the library, Internet services and other sources of knowledge for educational research Purposes.
- (6) To understand the procedure to conduct the research in the educational field.
- (7) To understand the nature of issues and problems faced by the State System of education and to find out the remedies to solve them.
- (8) To understand the role and use of statistics in educational research.
- (9) To select the appropriate statistical methods in educational research.
- (10) To review the educational research articles.
- (11) Use computers for data analysis.

#### UNIT-I: Concept of Educational Research

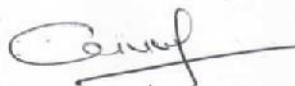
- 1.1 Meaning and nature, need and importance and scope of educational research.
- 1.2 Scientific Inquiry and Theory Development- some emerging trends in research.
- 1.3 Areas of educational research and different source of generating knowledge
- 1.4 Research Proposal

#### UNIT-2: Types and Methods of Educational research

- 2.1 Types of educational research – Fundamental, Applied, Action research
- 2.2 Methods of Educational Research:
  - (i) Qualitative Research- Ethno-methodical
  - (ii) Quantitative Research
  - (iii) Research problems, Variables and Hypothesis
  - (iv) Population and Sampling



R. Zouari





### UNIT-3 Review of related literature-

- 3.1 Purpose and need at different stages of research, sources of literature
- 3.2 Tools and Techniques of Educational Research- meaning and types of tools
- 3.3 Qualities of a good measuring tool and standardization procedure.
- 3.4 Collection of Data, Methods of collection of data.

### UNIT-4 : Analysis and Interpretation of Data


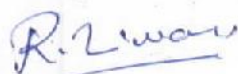
- 4.1 NPC- Properties and uses, Skewness and Kurtosis
- 4.2 Descriptive Statistics – Significance and uses of:
  - (i) Measures of Central tendency – Mean, Median, Mode.
  - (ii) Measures of variability – Range, Q.D. , S.D.
  - (iii) Measures of relative positions: Quartile, Deciles, Percentile and percentile rank, standard scores and T scores.
- (i) Correlation – Concepts, types and uses; assumption and uses of rank difference ,computation of rank difference correlation and Product Moment Method,
- (ii) Concepts- Bi-serial, point bi-serial- partial and multiple correlation and phi-coefficient.
- (iii) Regression equation and predictions

### UNIT-5: Inferential Methods.

- 5.1 Concept of parameter, statistic, sampling distribution, sampling error, and standard error.
- 5.2 Levels of significance, confidence, limits and intervals, degrees of freedom, types of error- Types I, Type II; Tests of significance of mean and of difference between means (both large and small samples) one and two tailed tests.
- 5.3 Parametric and non-parametric Statistics: uses and computation of Chi-square test and Contingency coefficient.
- 5.4 Educational Research Report Writing (i) Format, Style, content and chapterisation (ii) Bibliography, Appendices (iii) Characteristics of a good research report.

### PRACTICAL WORK: (any one)

- (i) Review of Educational research report/article.
- (ii) Data analysis using computer

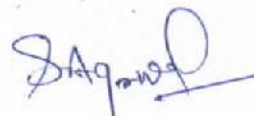
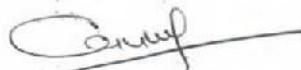


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10. Fox David J : Techniques for the Analysis of Quantitative Data, Holt, Rinehart, & Winson, Inc.1969.
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R. L. Rawan





## CORE STUDY ( SEMESTER II )

### PAPER VI : PSYCHOLOGICAL PERSPECTIVES OF EDUCATION

#### Objectives:

To enable students:

- (1) To develop understanding of the Psychological basis of Education
- (2) To understand the Cognitive, Affective and Psychomotor development of adolescents and youth.
- (3) To develop the understanding of the theories of Personality and their use in the development of learner's Personality, measurement of personality.
- (4) To understand the Changing Concept of Intelligence and it's application.
- (5) To understand the theories of Learning and their Utility in the Teaching Learning Process.
- (6) To understand the Concept and Process of teaching.

#### UNIT-1 Introduction to Psychological Basis of Education

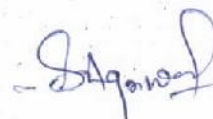
- 1.1 Psychology as scientific study, its concerns-mind, consciousness, behavior, and experience: methods of study in psychology- introspection/self-reporting- observation, survey, case/study, interview, testing, Experimental.
- 1.2 Major schools of psychology-Structuralism, associationism behaviorism, Gestalt, Psycho-analytic, Humanistic and Cognitive.
- 1.3 Contribution of these Schools to Education.

#### UNIT-2 Development

- 2.1 Development – Concept, stages, dimensions.
- 2.2 Factors influencing development – genetic, biological environmental and physical.
- 2.3 Theories of development
  - Piaget's Cognitive development
  - Freud's Psycho-sexual development
  - Erikson's psycho-social development
  - Kohlberg's moral development
- 2.3 Language development with reference to syntax and structure
- 2.4 Social development – Erisco's Psycho-socio test.
- 2.5 Moral Development- Theories of Piaget and Kolhers.



R. Z. Usan



### **UNIT – 3 Personality, Intelligence and Creativity**

- 3.1 Theories of personality
- 3.2 Measurement of Personality
- 3.3 Intelligence
- 3.4 Nature and Theories of Intelligence
- 3.5 Measurement of Intelligence – Verbal, Non-Verbal Performance, Individual and Group Test of intelligence developed in India
- 3.6 Creativity
- 3.7 Creativity Concept, Factors and process, techniques for development of Creativity. Brain-Storming, Synectics, Attribute – listing.

### **UNIT- 4 Learning**

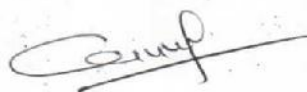
- 4.1 Theories of Learning
  - (i) Operant conditioning (Skinner)
  - (ii) Conditions of Learning (Gagne)
  - (iii) Information processing (Donald Norman)
  - (iv) Mastery learning (Bloom)
  - (v) Hull's reinforcement theory
  - (vi) Tolman's theory of learning
  - (vii) Levin's field theory
- 4.2 (i) Constructivism & learning. (ii) Brain base learning.
- 4.3 (i) Educational implications of theories of learning (ii) Factors influencing learning

### **UNIT-5 Teaching**

- 5.1 Models of teaching –concept and 4 families of models
- 5.2 Educational implications of researcher in the following areas in teaching :
  - (i) Teacher's thought processes
  - (ii) Student's thought processes
  - (iii) Teaching of learning strategies
  - (iv) Teacher behavior and student achievement
  - (v) Teaching functions
  - (vi) Classroom organization and Management



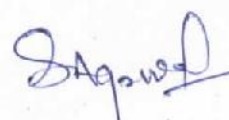
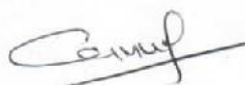
R. Zouari





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8. Wordsworth B.J. piaget's : Theory og cognitive and affective Development, New York, Longman incorporated, 1989.
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12. C.L. Kundu : Personality Development, Sterling publishers Pvt. Ltd., New Delhi, 1989
13. Charles N. Newmark : Major Psychological assessment Instruments : Allyn And Becan Inc. Boston, London, Sydney, Totonto, 1985.
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## SPECIALIZATION COURSE ( SEMESTER II )

ANY ONE COURSE IS TO BE CHOSEN FROM THE BELOW GIVEN:

- A) Educational Guidance and Counseling.
- B) Education for differently abled.

### PAPER VII ( A ) - EDUCATIONAL GUIDANCE AND COUNSELLING

#### COURSE OBJECTIVES:

1. To acquire the students with the concepts, needs and viewpoints about Guidance and Counselling and the underlying principles in reference to normal children as well as in reference to children with special needs.
2. To acquire the students with the organizational framework and procedures of Guidance-Services in educational institutions.
3. To acquire the students with the tools and techniques required for providing guidance and counselling services to students.

#### COURSE CONTENT

##### UNIT I

Guidance and Counselling : Concept, nature, need, scope and purpose; relationship with education; issues and problems; role of teacher

- Basic types of Guidance and the underlying principles, their nature, scope and purposes.
- Basic approaches of counselling and their underlying assumptions.

##### UNIT II

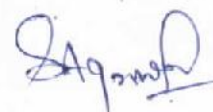
1. Educational Guidance: basic assumptions and principles
  - Curricular choice and its implications for Career guidance; Guidance and Curriculum and the class room learning.
2. Vocational Guidance: basic principles.
  - Vocational choice as a development process
  - Nature of work and Job analysis, dissemination of occupational information: vocationalisation of secondary education and career development

##### UNIT III

1. Personal Guidance: basic assumptions; types of behavioural problems of school stage students. Methods and strategies of Personal Guidance



R. Z. U. U.





2. Group Guidance: basic assumptions. Group Guidance and Individual guidance. Techniques of Group Guidance

#### UNIT IV

1. Counselling: Meaning, need, characteristics, principles of Counselling
2. Process and types of Counselling
3. Counselling theories

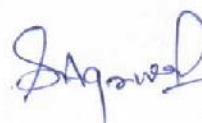
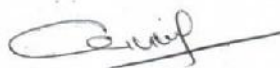
#### UNIT V

1. Guidance and Counselling in Groups: Nature, aim, Principles and procedure; Group Counselling Vs Individual counselling; counselling for adjustment. Types of group activities- their merits and demerits
2. Current Trends, Concerns and Demands in Guidance.

(SUGGESTED READINGS ARE GIVEN AT THE END OF SECOND PART OF THE PAPER IN SEMESTER-III)



R. Kumar



## SPECIALIZATION COURSE ( SEMESTER II )

### PAPER VII (B) - EDUCATION FOR THE DIFFERENTLY ABLED

#### OBJECTIVES:

- 1) To enable the learner to understand the concept of Inclusive, Integrated and special education, need of special education and its practices.
- 2) To understand the various suggestions of recent commissions of education for the differently abled for realizing the concept of universalisation of education.
- 3) To enable the learner with the new trends in education for the differently abled with respect to the curriculum.
- 4) To enable the learner to identify the specific needs characteristics and modalities of identification of various types of differently abled.
- 5) To enable the learner with the educational programmes, equipments and aids for the differently abled.

#### PART - I

#### COURSE CONTENTS

##### UNIT I

Inclusive, Integrated and Special education-concept, meaning and difference. Concept of mainstreaming from segregated, integrated to inclusive. Introduction to education for the disabled, its objectives, assumptions and scope. Key terms – Handicap, Impairment and disability. Historical perspectives of special education.

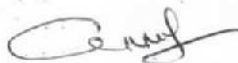
Special education in India: Constitutional provisions , government policies and legislations. Recommendations of various Committees and Commissions – NPE (1986), POA (1992) , PWD ( Person's with Disability ) Act (1995). National Institutes for the handicapped and the role of rehabilitation Council of India.

##### UNIT II

Current issues in education for the differently abled. Cross Disability Approach. Meaning of educational intervention: Nature and objectives of schools and support services for differently abled . Role of family, counselor, peer members and the community in educating the child.



R. Zivan



S. Agnival



### UNIT III

Types of special children : children with exceptional abilities- creative and gifted ; with deficiency and handicaps - mentally retarded , sensory and physically disabled ; with learning disability – slow learners ,under achievers ,and other types of learning disabled ; with social and emotional problems – truant ,delinquents ,drug addicts .Easy identification and educational programmes and their placement.

### UNIT IV

Children with exceptional abilities: Types – Gifted and creative ;Meaning, characteristics and identification of each type. Measurement of creativity and fostering activities and programmes for creativity. Psychology of teaching and learning in respect to the gifted and the creative.

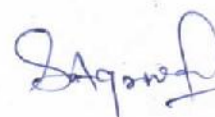
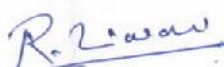
Curriculum, Pedagogy , evaluation and placement for each type.

### UNIT V

Problem children : concept , meaning of truants , delinquents , drug addicts and other types of problem children. Etiology and prevention. Preventive measures and educational programmes ; placement of delinquents , drug addicts and other types.

### PRACTICUM

Visit to integrated school : identification of creative child – measurement of creativity ( SUGGESTED READINGS ARE GIVEN AT THE END OF PART II )



## CORE COURSE ( SEMESTER III )

### PAPER VIII - HISTORY AND DEVELOPMENT OF EDUCATION IN INDIA

#### Course Objectives-

1. To be acquainted with the salient features of education in India in Ancient & Medieval times.
2. To be acquainted with the development of education in British India.
3. To be acquainted with the development of education in Independent India, including significant points of selected Education.
4. To be acquainted with current issues and trends in Education.

#### UNIT- I

1. Synoptic study of Brahmanic, Buddhist and Islamic Education in Ancient and Medieval India with respect to (a) Aims and Objectives (b) Subject of study (c) Methods of teaching including teacher – Pupil relationship. (d) Evaluation (e) Centre of Learning (f) Education of woman (g) Education in Ancient and Medieval India, characteristics of Gurukul, Matha/Vihar, Madarasah of and Makhtabs.
2. Brief outline of events relating education from 1757 to 1947 - Missionaries activities (Srirampur Trio) (3) Charter Act of 1813 Bengal Renaissance – Contribution of Rammohan Ray H.L.V. Derozio. And Vidyasagar. Adams Report. Anglicist–Orientalist controversy– Macaulay's Minute & Bentinck's resolution. Wood dispatch (Recommendations only)

#### UNIT-II

Brief outline of Hunter Commission 1882-83 (Primary and Secondary Education), Curzon Policy (Quantitative development of Primary education, Quantitative and Qualitative development of Secondary education, Qualitative development of Higher education). National Education Movement (cause and effect) Calcutta University Commission (1917-1919), Basic Education (concept & development), Sargent Plan, Gokhle-bill, Sadler commission, Wardha Scheme.

UNIT-III: (1). Constitutional provision for Education in India (2). Brief outline of the recommendations made by different Education Commission: (3). University Education Commission (1948-49) (4). (Aims of Higher education & Rural University) Secondary Education Commission (1952-53) (5). Aims, Structure & Curriculum of Secondary education) Indian Education Commission (1964-66), National knowledge commission.



**UNIT-IV** (1) National Policy on Education (1986). (2) Current issues in education: Equalization of Education Opportunities. (3) Programmes on Universal Elementary Education (DPEP & SSA) (4) Non-formal education and alternative schooling, Education of women.

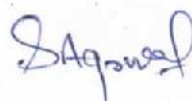
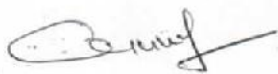
**UNIT-V** : (1) Problems in Indian Education ; Secondary & Higher Secondary Education, Environmental Education, Vocational Education. (2) Experiments in Indian Education; About Eminent Vishwa Vidhyalaya in India like- Shanti Niketan, Nalanda University, Vanasthali University etc.

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R. Rawat



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R. Z. Wani

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S. Agawal



**CORE STUDY ( SEMESTER III )**

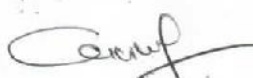
**PAPER IX - ECONOMIC & POLITICAL PERSPECTIVES OF EDUCATION**

**UNIT – I Economic Approach to Education**

- Economics of Education
- Financing of Education
- Financing Higher Education in India
- Finance Commission and Allocation of Resources to the states for Education
- Economic problems of Education – related to quality and quantity. UNIT – II Educational Economy & Planning
- Meaning and nature of Economic Planning with special reference to Education
- National Budget of Education
- Principles of Educational Finance
- Methods of Financing Education
- Cost of Education
- Sources of income in Education – Govt., Private & Cooperative patterns of investment in Education
- Grants-in-Aide – Types, principles, practices & procedure UNIT- III Educational Finance
- Educational Finance – Need, Significance & Principles
- Concept of Educational Finance
- Demand for Education
- Supply of Education
- Educational Financing in India – a historical perspective UNIT – IV: Political perspective of Education
- Needs of education of Free India
- World New Trends of Education
- Five Year plans in India – Its historical background
- Main features of Five Year Plans with special reference to Education
- Impact of Five Year Plans on Education



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- Perspective Plan for education in the 11th Five Year Plan

#### UNIT – V Educational Policy

- Indian Constitution & Its provisions for Education, Various articles related to Education, RTE
- Need and importance of Education Policy
- Types of Educational Policy – National, State Level & Institutional Level
- Role, Function & Impact of following organizations in upliftment of Education
  - NCERT
  - UGC
  - NCTE
  - SCERT
  - NUEPA
- Recent Initiatives in Education
  - At National level
  - At Chhattisgarh State Level
  - At District Level

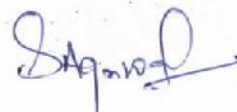
#### Reference Books:

1. History & Problems of Education – Volume I & Volume II Yogendra K. Sharma
2. UNESCO – Economic & Social aspects of Educational Planning – 1963
3. N.C.E.R.T – NCERT – The First Year Book of Education – 1961
4. Bell & Bell (2006) Education Policy & Social Class, Routledge
5. Naik J.P. (1965) Educational Planning in India, New Delhi: Allied
6. Mathur S.P. (2001) : Financial Administration & Management – The Indian Publications, India
7. Ramcharan Padma & R.Vasantha (2005) : Education in India, New Delhi, National Book Trust
8. Blaug, Mark (1972) An Introduction to Economics of Education – Allen Lane, The Penguin, London
9. Tilak, J.B.G (1988) Cost of Education in India – International Journal of Educational Development



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10. Educational Planning & Management – Premila Chandran Sekaran, Sterling Publication Pvt. Ltd.
11. Perspectives of education – Mahesh Bhargava & Rajshree Bhargava, H.P. Bhargava Book House, Agre
12. Educational Planning, Budgeting & Financing in India, J.C. Aggarwal, Arya Book Depot, New Delhi.



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**( E ) ELECTIVE II ( SEMESTER III )**

**PAPER X (A) - ADVANCED EDUCATIONAL STATISTICS**

**OBJECTIVES:**

To enable the students

- (1) To understand the role and use of advanced Statistics in educational research.
- (2) Select appropriate statistical methods in educational research
- (3) To understand various Statistical measures for interpretation of data.
- (4) To interpret the Statistical data.

**UNIT- 1: The Normal distribution & Statistical measures.**


- 1.1 Properties of normal probability distribution
- 1.2 Defects in normality-1 Skewness, 2. Kurtosis
- 1.3 Applications of normal probability curve
- 1.4 Statistical Measures
- 1.5 Difference between Statistical Measures
- 1.6 The significance of mean, median, standard deviation, quartile deviation, percentage and correlation.
- 1.7 The significance of difference, coefficient of correlation
- 1.8 Meaning of partial and multiple correlation
- 1.9 Simple applications of partial and multiple correlation
- 1.10 Biserial Correlation – Point biserial correlation
- 1.11 Phi-correlation-contingency coefficient

**UNIT- 2: The scaling of tests**

- 2.1 Sigma scaling and standard scores
- 2.2 T scaling
- 2.3 Stanine scaling
- 2.4 Percentile scaling
- 2.5 The reliability of test scores and methods of determining it.
- 2.6 Validity of test scores and determining validity
- 2.7 Item analysis



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**UNIT 3: Analysis of Variance**

- 3.1 Meaning of variance
- 3.2 Method of analyzing variance
- 3.3 Meaning of Covariance
- 3.4 Analysis of Co-variance

**UNIT 4: Testing of Experimental hypothesis by, non parametric tests**

- 4.1 Chi-square test
- 4.2 Sign test
- 4.3 Median test
- 4.4 Man Whitney U test

**UNIT-5: Regression and prediction.**

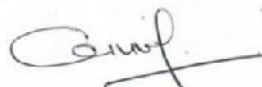
- 5.1 Nature of Scatter- diagram
- 5.2 Meaning of regression
- 5.3 Regression equations
- 5.4 Application of regression equations in prediction

**Reference Books:**

- 1. H.E. gareth- Ststistics on Psychology & edn, Longman Green & co., London
- 2. B. fruchter-Introd l. lction to factor analysis – D Van Hostrand & co., N.Y.
- 3. G Thompson – Frctoranalysis of human Ability, University of London Press
- 4. Albert Kurtz Semual Mayo –Statistical Methods in education and Psychological springer International student edition.



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## ELECTIVE COURSE II ( SEMESTER III )

### PAPER X (B)- EDUCATIONAL ADMINISTRATION AND MANAGEMENT

#### OBJECTIVES:

- (1) To enable the learner to become effective manager of teaching /Administration of Education.
- (2) To enable learner to become & agents of change in various aspects of education i.e. classroom management, curriculum construction, examination systems, Educational policies.
- (3) To acquaint the learner with the challenges and opportunities emerging in the management and administration in education.
- (4) To acquaint the learner with the Central and State machinery for educational administration and management.
- (5) To make the students understand about the finance, management of Education.
- (6) To make the student familiar with the new trends and techniques of education.
- (7) To enable the students to get some insight into supervision, inspection and know trends of development
- (8) To development an understanding of the planning of education in India and its Socio-economic context.

#### UNIT- 1: Management concept and process

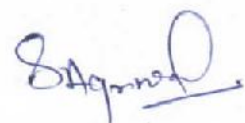

- 1.1 Management – concept, Need of Management, Characteristics of good Management.
- 1.2 Management at different levels-Elementary Higher, secondary Higher Education, Time Management, Functions of Management
- 1.3 Leadership –Meaning and nature of Leadership, Theories of Leadership, Styles of Leadership and Measurement of Leadership.
- 1.4 Role of Management/Principal characteristics of effective Educational leadership, Time management techniques, manager as a good leader, group dynamics and motivation.

#### UNIT 2: Application of Management concept in Academic areas of the educational systems-

- 2.1 Curriculum development /Evaluation
- 2.2 Teaching Learning Processes
- 2.3 Evaluation Assessment (Management, Manager, Teacher, student, Parents)- Self Appraisal.
- 2.4 Professional Growth- In service Training
- 2.5 Planning in Education – Approaches to Educational Planning



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- 2.6 Communication,
- 2.7 Communication skills. (Verbal, non-verbal-written),
- 2.8 Barriers and distortions in communication.
- 2.9 Information Systems- Modern Information Technology.

#### **UNIT – 3 Machinery for educational Administration**

- 3.1. Central Machinery (CABE,NCTE,UGC,)/ State Machinery for educational Administration,.
- 3.2 Organization and functions of directorate of Education.
- 3.3 Roll of Central Govt., State Govt., and local bodies in education at all levels.
- 3.4 Trends in Educational Management
- 3.5 Decision Making – Nature, division of work, Centralization action and Decentralization of decision making, their merits and limitations.
- 3.6 Organizational compliance.
- 3.7 Organizational Development.

#### **UNIT 4 Finance Management-**

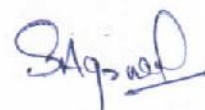
- 4.1 National budget of Education
- 4.2 Principles of Educational finance
- 4.3 Methods of Financing Education
- 4.4 Source of Income: Govt, Private and co-operative patterns of investment in education- past, present and future.,
- 4.5 Grant – in-aid principles, practices, types and procedure in- respect of University level.
- 4.6 Cost of Education.

#### **UNIT- 5 Quality Management in Education**

- 5.1 Meaning and importance of Quality
- 5.2 Quality in Higher Education
- 5.3 Accreditation Concept- Meaning, parameters, Role of NAAC
- 5.4 Educational Supervision and inspection –
- 5.5 Meaning and Nature of Educational Supervision
- 5.6 Functions of a supervisor, Defects in existing system of supervision, Remedies.



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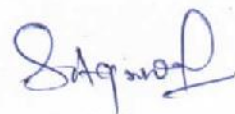



**Practical – Any one**

- (1) Educational Survey of any state educational Institution.
- (2) Report on an Institutional Planning of any one Educational Institute.
- (3) Report on an Educational Institute on Quality Management.

**Reference Books:**

1. School Organisation and Administration- M.S. Sachdeva
2. Management in Education- Namita Roy chaudhary A. P.H. Publishing corporation, New Delhi.
3. Educational Planning and Management Premila Chandrasekaran, sterling Publication Pvt. Ltd.
4. Educational Administration and Management – S.S. Mathur
5. Theory of Educational Administration- S.R. Vashost
6. Efficient School Management and Role of Principals- Alka Karla
7. Administrative Strategy and Decision making- Hardwick Landuyt
8. Administration and management of Education- dr. S.R. Pandya, Himalaya Publishing House
9. Educational Administration Planning and Supervision- T.P. Lambal, V.R. Saxena, V.Murthy, Delhi Daoba house
10. School Organisation and Administration- U.S. Sidhu
11. Administration of Education in India- S.N. Mukharji
12. Educational Administration Principles and Practices- S.S. Mathur





## CORE COURSE ( SEMESTER III)

### PAPER XI - GENDER PERSPECTIVES AND EDUCATION

#### Aims of the Course:

This course will enable the students to

- Develop basic understanding and familiarity with key concepts—gender, gender bias, gender stereotype, empowerment, gender parity, equity and equality, patriarchy and feminism;
- Understand the gradual paradigm shift from women's studies to gender studies and some important landmarks in connection with gender and education in the historical and contemporary period;
- Learn about gender issues in school, curriculum, textual materials across disciplines, pedagogical processes and its intersection with class, caste, religion and region; and
- Understand how gender, power and sexuality relate to education (in terms of access, curriculum and pedagogy).

#### UNIT 1: GENDER ISSUES: KEY CONCEPTS

In this Unit the students will develop an understanding of some key concepts and terms and relate them with their context in understanding the power relations

- 1.1 Gender, sex, sexuality, patriarchy, masculinity and feminism
- 1.2 Gender bias, gender stereotyping, and empowerment
- 1.3 Equity and equality in relation with caste, class, religion, ethnicity, disability and region.

##### Suggested Practicum

- Preparation of project on key concepts and relating it with the social context of the pupil teacher
- Analysis of textual materials from the perspective of gender bias and stereotype
- Organising debates on equity and equality cutting across gender, class, caste, religion, ethnicity disability, and region.

#### UNIT 2: GENDER STUDIES: PARADIGM SHIFTS

In this Unit, the students will develop an understanding of the paradigm shift from women studies to gender studies, based on the historical backdrop. They would be able to construct critically the impact of policies, programmes and scheme for promotion of gender equality and empowerment.



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- 2.1 Paradigm shift from women's studies to gender studies
- 2.2 Historical backdrop: Some landmarks from social reform movements of the nineteenth and twentieth centuries with focus on women's experiences of education
- 2.3 Contemporary period: Recommendations of policy initiatives commissions and committees, schemes, programmes and plans.

#### **Suggested Practicum**

- Preparation of project on critical analysis of recommendations of commissions and policies on capacity building and empowerment of girls and women, how these initiatives have generated in the formation of women collectives and have helped in encouraging grassroots mobilisation of women, such as the Mahila Samakhya programmes
- Project on women role models in various fields with emphasis on women in unconventional roles.

### **UNIT 3: GENDER, POWER AND EDUCATION**

In this Unit, the students will develop an understanding of different theories on gender and education and relate it to power relations. The institutions involved in socialisation processes would be analysed to see how socialisation practices impact power relations and identity formation.

#### **3.1 Theories on Gender and Education: Application in the Indian Context**

- Socialization theory
- Gender difference
- Structural theory
- Deconstructive theory

#### **3.2 Gender Identities and Socialisation Practices in:**

- Family
- Schools
- Other formal and informal organisation.

#### **3.3 Schooling of Girls:**

Inequalities and resistances (issues of access, retention and exclusion)

#### **Suggested Practicum**

- Discussion on theories of gender and education with its application in the Indian context
- Project on analyzing the institution of the family



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- (i) Marriage, reproduction
- (ii) Sexual division of labour and resources
- Debates and discussions on violation of rights of girls and women
- Analysis of video clipping on portrayal of women
- Collection of folklores reflecting socialisation processes.

#### **UNIT 4: GENDER ISSUES IN CURRICULUM**

Students will build on the previous two Units to understand how gender relates to education and schooling. In this Unit, the students will be able to understand on how school as an institution addresses gender concerns in curriculum, textual materials and pedagogy. It will enable the student to draw linkages between life skills and sexuality.

- 4.1 Gender, culture and institution: Intersection of class, caste, religion and region
- 4.2 Curriculum and the gender question
- 4.3 Construction of gender in curriculum framework since Independence: An analysis
- 4.4 Gender and the hidden curriculum
- 4.5 Gender in text and context (textbooks' inter-sectionality with other disciplines, classroom processes, including pedagogy)
- 4.6 Teacher as an agent of change
- 4.7 Life skills and sexuality. Suggested Practicum
  - Preparation of indicators on participation of boys and girls in heterogeneous schools—public and private-aided and managed by religious denominations
  - Preparation of tools to analyse reflection of gender in curriculum
  - Preparation of checklist to map classroom processes in all types of schools
  - Field visits to schools, to observe the schooling processes from a gender perspective.

#### **UNIT 5: GENDER, SEXUALITY, SEXUAL HARASSMENT AND ABUSE**

The Unit will enable students to apply the conceptual tools learnt regarding gender and sexuality to understand issues related to Sexual Harassment at the workplace and Child Sexual Abuse.

- 5.1 Linkages and differences between reproductive rights and sexual rights
- 5.2 Development of sexuality, including primary influences in the lives of children (such as gender, body image, role models)
- 5.3 Sites of conflict: Social and emotional
- 5.4 Understanding the importance of addressing sexual harassment in family, neighbourhood

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and other formal and informal institutions

5.5 Agencies perpetuating violence: Family, school, work place and media (print and electronic)

5.6 Institutions redressing sexual harassment and abuse. Suggested Practicum

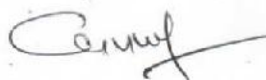
- Project on how students perceive sexuality and their own body images. It would also focus on how gender identities are formed
- Debate on how they perceive role models in their own lives
- Preparing analytical report on portrayal of women in print and electronic media.

#### Suggested Readings:

1. Gender Analysis of State Policies: A case study of Chhattisgarh, Dr. Sen Ilina
2. Towards Gender Equality in Education: Progress and challenges in Asia-Pacific Region, R. Govinda, National University of Educational Planning and Administration, New Delhi.
3. Bhattacharjee, Nandini (1999) Through the looking-glass: Gender Socialisation in a Primary School in T. S. Saraswathi (ed.) Culture, Socialization and Human Development: Theory, Research and Applications in India. Sage: New Delhi.
4. Geetha, V. (2007) Gender. Stree: Calcutta.
5. Ghai, Anita (2008) Gender and Inclusive education at all levels In Ved Prakash & K. Biswal (ed.) Perspectives on education and development: Revising Education commission and after, National University of Educational Planning and Administration: New Delhi
6. Jeffery, P. and R. Jefferey (1994) Killing My Heart's Desire: Education and Female Autonomy in Rural India. in Nita Kumar (ed.) Women as Subjects: South Asian Histories. New Delhi.
7. Learning, Livelihoods, and Social Mobility: Valuing Girls' Education in Central India, Peggy Froerer, Brunel University, Anthropology and Education.



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## **CORE STUDY ( SEMESTER IV )**

### **PAPER XII CURRICULUM DEVELOPMENT**

#### **OBJECTIVES:**

- (1) To understand the concept and principles of curriculum development.
- (2) To understand and appreciate curriculum as a means of development of the individual.
- (3) To gain insight in to the development of new curriculum.
- (4) To understand the Foundations of curriculum development.
- (5) To appreciate the need for continuous Curriculum reconstruction.
- (6) To help the student to develop skills in framing curriculum for subjects of teaching, analyzing curriculum for teaching-learning process and developing course contents in the subjects of teaching.

#### **UNIT – 1 Principles of Curriculum Development**

- (a) Meaning and Concept of Curriculum
- (b) Concept of Curriculum development
- (c) Stages in the Process of Curriculum development
- (d) Curriculum Syllabus and Units

#### **UNIT- 2 Philosophical, Sociological and Psychological foundation of curriculum.**

- (a) Philosophical theories and their implications to Curriculum.
- (b) Sociological needs and their implications for curriculum development.
- (c) Psychological needs their implications for curriculum development.
- (d) Curriculum development and teaching-learning process.

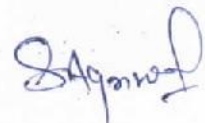
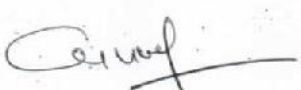
#### **UNIT-3 Curriculum Development**

- (a) Need and Scope for Curriculum development, Criteria for Future Curriculum development and Characteristics of a good Curriculum.
- (b) Strategies of Curriculum development.
- (c) Guiding Principles for Curriculum development.
- (d) Organization of Curriculum

#### **UNIT-4 Procedure of organizing Content**



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- (a) Formation of general objectives at School stage and their specification.
- (b) Formation of instructional objectives and their specifications
- (c) Terms of expected behavior changes in the students.
- (d) Suggesting appropriate content to fulfill the objectives.

#### 4.1 Factors responsible for innovations in curriculum development.

- (a) Problems of curriculum reform.
- (b) Periodic revisions of curriculum in view of the knowledge.
- (c) Evaluation as an integral part of curriculum development.
- (d) Need for permanent curriculum research unit.

#### UNIT-5 Evaluating the Curriculum


- (a) A frame work for evaluation
- (b) Planning for evaluation
- (c) Conducting the Programme evaluation
- (d) Evaluating the curriculum materials
- (e) Conducting the Curriculum material evaluation

#### PRACTICAL WORK

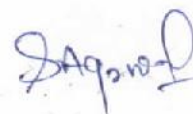
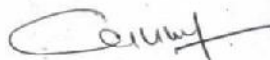
1. Seminar on one of the topic assigned.
2. Critical analysis of the existing curriculum at various levels- primary/Secondary/Higher Secondary.
3. A report on the recent research on curriculum development
4. A Comparative study of two syllabi-state Government/ ICSE.

#### Reference Books:

1. Curriculum Organization and Design- Jack Walton, Great Briton
2. Curriculum and lifelong Education- Studies for UNESCO
3. School Curriculum- Mohmmad Sharif Khan- ASHISH Publishing House, New Delhi.
4. The Improvement of Curriculum in Indian Schools H.E. Harmay, Ministry of Education.
5. Curriculum reform – B.D. Bhatt, Kanishka Publishers, New Delhi



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6. Developing the Core Curriculum 3/ 4 roland C. Faunce, Nelson L. Bossing, Prentice Hall of India, New Delhi
7. Evaluation and Research in Curriculum Construction- M.I.Khan I B.K. Nigam- Kanishka, Publisher, New York
8. Curriculum Development & Educational Technology Mamidj,S.Ravishankar- Sterling Publishers.

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## SPECIALIZATION COURSE ( SEMESTER IV)

### PAPER XIII ( A ) – EDUCATIONAL GUIDANCE AND COUNSELING ( PART II )

#### UNIT I

1. Bases of guidance: Philosophical, Sociological, Pedagogical, Psychological
2. Concept of guidance: Meaning, Basic assumptions Need of guidance, Influence of family and Community on guidance. Functions and purposes of Guidance.
3. Types of guidance: Major guidance areas- Personal, educational, Career, Social, Health, Marital, Moral.
4. Adjustive guidance: Identification of maladjusted children and the principles of dealing with them.

#### UNIT II

1. Guidance of children with problems and special needs: gifted and creative; Role of the teacher in helping such children.
2. Group guidance: concept and techniques of group guidance.
3. Principles of mental hygiene and their implications of effective adjustment; mental health and development of integrated personality.

#### UNIT III

1. Guidance services: Individual Inventory and Information counselling Group Guidance services, Placement services and Follow-up services.
  - Guidance of children with special needs, role of teacher.
2. Organization of a Guidance programme and its principles-at elementary, secondary, college and university levels.
  - Evaluation of Guidance programmes

#### UNIT IV

1. Guidance and Appraisal of the Individual: meaning, need, purpose and place of appraisal in Guidance.
2. Techniques of Appraisal: Testing techniques - tests (viz. Intelligence, Aptitude, Knowledge and Achievement), Interest tests and Personality measures.
  - Non-Testing Techniques–Rating scales, Questionnaires, Inventories, records and sociometric tools.



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## UNIT V

1. Job Analysis: Meaning and objectives of job analysis
2. Outline for job study
3. Job profiles
4. Job satisfaction

### Practical Work (any one)

1. Job analysis of any one occupation
2. Prepare an interview schedule for an effective Counselling
3. Visit a guidance Centre and Write a report about its organization and functions.

### Reference Books:

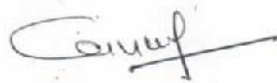
- ❖ Blocher, D.H. et al., (Eds. 1971): Guidance systems, New York: The Ronald Press Co.
- ❖ Bhatnagar, A. & Gupta, N. (Eds. 1999): Guidance and Counselling: A Theoretical Perspective, New Delhi: Vikas Publishing House.
- ❖ Lakshmi, K.S. (Eds. 2000) : Encyclopaedia of Guidance and Counselling, New Delhi: Mittal Publications.
- ❖ Shaw, M.C. (1973): School Guidance Systems. Boston: Houghton Mifflin Co. Anastasi, A. (1982). Psychological testing. London: Collier Macmillan Publishers.
- ❖ Bernard, H.W. & Fullmer, D.W. (1972). Principles of Guidance- a basic text. Bombay: Allied Publishers.
- ❖ Dink Mayer, D.C. & Caldwed, C.I. (1970). Development Counselling and Guidance- A Comprehensive School Approach. New York: Mac Graw Hill.
- ❖ Donald, H.B. Richard, D.C. & Willier, E.D. (1971). Guidance Systems- An introduction to student personal work. New York: The Ronald Press Company.
- ❖ Fullmer, D.W. & Bernard, H.W. (1972). Counselling: Content and Process. New Delhi: Thompson Press.
- ❖ Hackney, H. & Nye, S. (1973). Counseling Strategies and Objectives. New Jersey: Prentice Hall Inc.
- ❖ Indu Dane (1983). The basic essentials of counselling. New Delhi: Sterling Publishers Pvt.
- ❖ Jones, Stafflire & Stewart (1978). Principles of Guidance Sixth Edition. New Delhi: Mac Graw Hill.

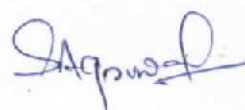
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- ❖ Mortensen, D.U. & Schumuller, A.M. (1976). Guidance in todays schools. New York: John Willy & Sins. Inc.
- ❖ Moser & Moser (1963). Counselling and Guidance an Exploration. New York: Prentice Hall Inc. Patterson, C.H. (1980). Theories of Counselling and Psycho Therapy. New York, Harper and Roul.
- ❖ Richard, C.N. (1972). Guidance and Counselling in the Elementary School. New York: Hlot Rineheart and Winston Inc.
- ❖ Robert Basell (1971). Interviewing and Counselling. London: H.T. Batsford, Ltd. Stefflee & Grant (1972). Theories of Counselling. New York: McGraw Hill.
- ❖ Traxler & North (1966). Techniques of Guidance. New York: Harper & Row Publishers. Super, D.E. & Crites, J.O. (1966). Appraising Vocational Fitness, Harper & Row.
- ❖ Raj Singh (1994). Educational and Vocational Guidance. New York: Commonwealth Publishers.



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## SPECIALIZATION COURSE ( SEMESTER IV )

### PAPER XIII ( B ) – EDUCATION FOR THE DIFFERENTLY ABLED( PART II )

#### COURSE CONTENTS

##### UNIT I

1. Children with physical disabilities: Basis of classification (Physical, physiological, social, psychological and mental), characteristics and etiology of each type and difference between them.
2. Education of visually impaired: Concept , Characteristics, Types (degree of impairment). Etiology and prevention.
3. Psychology of teaching and learning in relation to the disability and their specific needs. Curriculum, pedagogy, evaluation and placement . Role of National Institute for the visually impaired.

##### UNIT II


1. Education for the hearing impaired: Concept, Characteristics, Types (degree of impairment). Etiology and prevention.
2. Psychology of teaching and learning in relation to the disability and their specific needs. Curriculum, pedagogy, evaluation and placement. Role of National Institute for the hearing impaired.

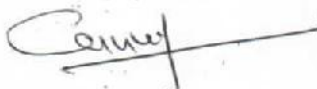
##### UNIT III

1. Education for the Orthopaedically handicapped : Concept , Characteristics , Types (degree of impairment). Etiology and prevention.
2. Psychology of teaching and learning in relation to the disability and their specific needs. Curriculum, pedagogy, evaluation and placement. Role of National Institute for the orthopedically handicapped.

##### UNIT IV

1. Education for the mentally retarded: Mentally retarded, slow learners, backward and learning disabled children. Concept, Characteristics, Etiology and prevention.
2. Psychology of teaching and learning in relation to the disability and their specific needs. Curriculum, pedagogy, evaluation and placement. Role of National Institute for the Mentally retarded.

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## UNIT V

1. Socially deprived and emotionally disturbed children: Concept, characteristics and types (Dyslexic and delicate). Etiology and prevention.
2. Psychology of teaching and learning in relation to the disability and their specific needs. Curriculum, pedagogy, evaluation and placement .
3. Practicum

### Books Recommended:

1. Bender, W.N. Learning Disability, Allyn & Bacon, Simon and Schuster, 1995, Boston London
2. Berdine, W.H & Blackhurst A.E.(eds). An Introduction to Special Education, Harpers Collins Publishers, Boston 1980.
3. Dunn., L & Bay, D.M (ed.): Exceptional Children in the Schools, New York : Holt, Rinehart, Winston.
4. Hallahar, D.P & Kauffman, J.M., Exceptional Children: Introduction to Special Education, Allyn & Bacon, Massachusetts, 1991
5. Hewett, Frank M. & Foreness Steven R., Education of Exceptional Learners, Allyn & Bacon, Masachusetts, 1984.
6. Jorden, Thomes E. The Exceptional Child, Ohio: Merrill.
7. Kirk, S.A & Gallagher J.J., Education of Exceptional Children ; Houghton Mifflin Co., Boston, 1989
8. Magnifico, L.X: Education of the Exceptional Child, New York, Longman.
9. Shanker, Udey: Exceptional Children, Jullundur: Sterling Publications.
10. Singh, N.N and Beale, I.L. (eds.) Learning Disabilities – Nature, Theory and Treatment Spring-Verlag, New York, Inc:1992.
11. Smith, C.R, Learning Disabilities – the interaction of Learner; Task and Setting. Allyn and Bacon, Massachusetts, 1991.
12. Strange, Ruth : Exceptional Children & Youth J.J. : Prentice Hall.



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## Minutes of Board of Studies

The meeting of Board of Studies in Regional Studies and Research was held on July 10, 2018 in School of Regional Studies and Research at 12:00 noon.

Following members were present:

1. Prof. Mitashree Mitra, Chairman, BoS  
School of Regional Studies & Research, Pt. RSU, Raipur

*Mitra*  
10/7/2018

2. Prof. Promila Singh – Member  
SoS in Psychology, Pt. RSU, Raipur

*Promila Singh*  
10/7/18

3. Prof. A.K. Pandey – Member  
SoS in Economics, Pt. RSU, Raipur

*A.K. Pandey*  
10-7-18

### **Business transacted:**

- : Approval of the Minutes of the last BoS Meeting.
- : Minutes of the last BoS meeting held on July 07, 2018 approved.

### **Agenda 1: Approval of PG course in Rural Development (2018-19)**

- : The existing syllabus of M.A. in Rural Development was thoroughly checked and approved.

### **Agenda 2: Approval of Ph.D. Entrance (Regional Studies/ Rural Development) & Ph.D. Course Work, M.Phil, P.G. Diploma in Regional Planning and Development, PG Diploma in Theory and Practice in Panchayat Monitoring and Evaluation and Three months Certificate Course on Rural Secretary (2018-19)**

- : Ongoing syllabi of P.G. Rural Development, Ph.D. Entrance Test (Regional Studies & Rural Development) & Ph.D. Course Work (Regional Studies & Rural Development) were approved with minor modification.

Syllabus for entrance test of PG Diploma in Regional Planning and Development was prepared and approved by the committee. Certificate course as mentioned above is approved

Approved syllabus is enclosed.

### **Agenda 3: Approval of Certificate Course in Community based Participatory Research (CBPR) (To be run by Centre for Women's Studies)**

- : As per MoU (signed on 05.02.2018) between PRSU, State Planning Commission and Society for Participatory Research in Asia (PRIA) under Knowledge for Change (K4C): An Global Consortium for Training in Community Based Research, the Certificate Course in Community Based Participatory Research (CBPR) is approved.

Committee approved the proposal and syllabus.  
The meeting ended with vote of thanks to the Chair.

*Mitra*  
10/7/2018

*Promila Singh*  
10/7/18

*A.K. Pandey*  
10-7-2018

# SYLLABUS

## **Certificate Course In Community Based Participatory Research**

**Centre for Women's Studies**

*Pt. Ravishankar Shukla University,  
Raipur (C.G)*

2018-2019



## Certificate Course In: Community Based Participatory Research

Module	Content
Module 1	<ul style="list-style-type: none"> <li>History and Development of Community Based Participatory Research</li> </ul>
Module 2	<ul style="list-style-type: none"> <li>Ethics and Values</li> </ul>
Module 3	<ul style="list-style-type: none"> <li>Steps in CBPR</li> <li>Modes of Inquiry</li> </ul>
Module 4	<ul style="list-style-type: none"> <li>Knowledge Mobilization: Representation of Knowledge</li> <li>Building &amp; sustaining research partnerships</li> <li>Reflections from face-to-face component</li> </ul>
Module 5	<ul style="list-style-type: none"> <li>Balancing Theory &amp; Practice</li> </ul>
Module 5	<ul style="list-style-type: none"> <li>Balancing Theory &amp; Practice</li> <li>Field study</li> <li>Reflections on Process of CBPR from Field Study</li> </ul>
Module 6	<ul style="list-style-type: none"> <li>MTP - Evaluation</li> </ul>

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## MODULE 1

### ➤ **History and Development of Community Based Participatory Research**

#### **Learning Objectives**

- **Become familiar with** the history and theoretical development of participatory research and CBPR
- **Discuss the** principles of CBPR
- **Describe your** field project using CBPR vocabulary

## MODULE 2

### ➤ **Ethics and Values**

#### **Learning Objectives**

- Understand research and the concept of neutrality.
- Explore principles of Indigenous Research ethics.
- Analyze approaches to ethics in other forms of CBPR.

#### **Discussion Questions**

- Ethics as a topic covers matters of harm, benefits, rights, responsibilities and relationships. What do you think are the distinctive ethical issues in CBPR and are they really that different from those that arise in 'traditional' research?
- 'Institutional ethical review boards are not really concerned about 'ethics' in the sense of promoting good human relationships and social justice, they are concerned about reducing risk and maintaining institutional reputations'. Is this an unfair characterisation? What is the value of institutional review boards/research ethics committees and what role can community-based ethical review play?
- If large institutions like universities, colleges, hospitals, or international NGOs are involved in CBPR, what steps can community-based organisations take to ensure more genuine power-sharing in the design and management of the research process and outcomes?

the role of ethical Review Boards-institutional and community level.

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## MODULE 3

### ➤ Steps in CBPR

#### Learning Objectives and Questions for the week

- Become familiar with co-construction of knowledge
- Understand special features of each research step in CBPR
- Learn the considerations in reaching agreement between community and researcher on the research question
- Define research question of your field study and its various steps
- There are spaces in the course space design to respond to three questions: 1) Are there examples of CBPR done only by groups or citizens outside the academy? When is co-constructed knowledge most useful? 2) What are the challenges in coming to a collective agreement with your community partner in the determination of the research question(s)? 3) Share your thinking at this stage of the steps that you will have in the CBPR work that you are planning?

### ➤ Modes of Inquiry

#### Learning Objectives

- Understand the significance of using multiple modes of research in CBPR.
- Develop an appreciation of diverse set of methods used in these different modes.
- Become familiar with methods of PAR, arts-based methods, and action-based methods.
- Begin to think about how you would teach these approaches with a CBPR framework

## MODULE 4

### ➤ Knowledge Mobilization: Representation of Knowledge

- After successfully completing this week, you will be able to:
  - Know how knowledge and research findings can be represented and communicated in powerful and engaging ways to diverse audiences-social media, exhibitions, demonstrations, petitions to the powerful, etc.

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## Knowledge mobilization, representing knowledge and sharing our results

As we have learned over the past weeks, how we communicate our results in CBPR is a critical part, perhaps the most important part of the CBPR process. The term 'knowledge mobilization' is used sometimes to describe the process of making sure that the results of our work have the impact that our communities want. Another way to think of knowledge mobilization is 'sharing the stories'.

The way that we share the results will vary according to our own cultural and political contexts, according to who needs to hear the stories and according to the issues that we are working on in our CBPR projects.

We want to hear from you about your ways of sharing knowledge from the research or about other ways of sharing knowledge that you have heard about in your parts of the world.

We want to build our own K4C Knowledge Mobilization Tool kit over time and we are starting with you as the first contributors.OK?

If you wish to read or see more about KM, there are some additional resources listed below, but the main thing is to contribute your own experience and ideas.

### Activity

- Online Discussion | Knowledge Mobilization Guide

## ➤ Building & sustaining research partnerships

### Learning Objectives

- Understand the benefits and challenges of building research partnerships.
- Analyze different knowledge cultures that need accommodation in nurturing strong research partnerships.
- Identify roles of key intermediaries and interface mechanisms in ensuring sustainability of such partnerships between universities and communities.
- Explore the use of formal MOUs and agreements as tools in partnership management.

## ➤ Reflections from face-to-face component

### Learning Objectives

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- Systematize your agenda for personal and professional development of competencies in CBPR.
- Prepare tips for use of various new methods practiced during past two weeks.

## MODULE 5

### ➤ **Balancing Theory & Practice**

#### **Learning Objectives**

- Understand the link between theory and practice.
- Understand issues of reliability and validity in research.
- Develop use of praxis in your field study.

#### **Activity**

- Online Discussion | Balancing Theory & Practice 1
- Online Discussion | Balancing Theory & Practice 2

### ➤ **Field study Impact Assessment**

#### **Learning Objectives**

- Analyze approaches to the assessment of impact in CBPR: institutional, political, personal, organizational
- Demonstrate commitment and responsibility to local community/civil society / social movements/partners.
- Reflections on Process of CBPR from Field Study

#### **Learning Objectives**

After successfully completing this week, you will be able to understand and apply:

- What has worked?
- What has not worked as you had hoped?
- What has surprised you in your work?

### ➤ **Reflections on Process of CBPR from Field Study**

#### **Learning Objectives**

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- What has worked?
- What has not worked as you had hoped?
- What has surprised you in your work?

### Activity and Assignment

## MODULE 6

### MTP - Evaluation

#### Post MTP - Evaluation

This is your opportunity to provide any final ideas you have about the MTP course. We also would like your ideas about how best to strengthen the K4C network so as to provide support for each of you and your colleagues going forward

#### Activity

- We will provide an individual evaluation form and welcome open ended reflections- all thoughts/ideas welcome

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# Reference

## Module 1

### History and Development of Community Based Participatory Research

#### Required Resources

- Hall, B., and Tandon, R. (2017) 'Participatory research: Where have we been, where are we going? – A dialogue'. Research for All, 1 (2): 365-74. <https://dspace.library.uvic.ca/handle/1828/8562>
- PRIA-logue 3rd Edition (2015). Participatory Research in Action: Where is the Future? A dialogue between Dr. Budd Hall and Dr. Rajesh Tandon.
  - **Part 1**
  - **Part 2**
- Etmanski et al. (2014), Introduction. In Etmanski et al. (eds), Learning and Teaching Community Based Research: Linking Pedagogy to Practice. Toronto: U of Toronto Press, pp 3-24. <http://ezproxy.library.uvic.ca/login?url=http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=704528>
- Fals Borda, O. (1980), Science and The Common People. In F. Dubell et al. (eds.), Research for the people – Research by the people. Selected papers from the International Forum on Participatory Research in Ljubljana, Yugoslavia. Linkoping University and SVE, The Netherlands Study and Development Centre for Adult Education, pp. 13-40. [https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod\\_folder/content/0/M4%20-%20Fals%20Borda%201980%20-%20Science%20and%20the%20common%20people.pdf](https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod_folder/content/0/M4%20-%20Fals%20Borda%201980%20-%20Science%20and%20the%20common%20people.pdf)
- Tandon, R.; Hall, B. (2014). Majority-World Foundations of Community Based Research. In Munck, McIllrath, Hall and Tandon (Eds.), Higher Education and Community Based Research: Creating a Global Vision. London: Palgrave MacMillan, pp. 53-68. <https://link-springer-com.ezproxy.library.uvic.ca/book/10.1057%2F9781137385284>

#### Additional suggested resources:

- Gutberlet, J., Tremblay, C., Moraes, C. (2014). The Community-based Research Tradition in Latin America. In Munck, R., McIlrath, L., Hall, B., & Tandon, R. (eds.), Higher Education and Community-based Research: Creating a Global Vision. Palgrave Macmillan. pp. 167-180. <https://link-springer-com.ezproxy.library.uvic.ca/book/10.1057%2F9781137385284>
- Loiselle et al. (2014), When Girls Talk Back: Learning through Doing Critical, Girl-Centred Participatory Action Research. In Etmansky et al. (Eds.), Learning and Teaching CBR, Ch. 2, pp. 45-69. <http://ezproxy.library.uvic.ca/login?url=http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=704528>
- Flipp, C. (2014). Video on CBPR. Language: English. Length: 8:55. <https://www.youtube.com/watch?v=AePC97aKOJA>

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## MODULE 2

### Ethics and Values

#### Required Resources

- Interview Sarah Banks - [https://www.youtube.com/watch?v=nePd3oTz\\_CU](https://www.youtube.com/watch?v=nePd3oTz_CU)
- Ethical Challenges in CBPR (Durham Conference, Feb 2013) - [https://www.dur.ac.uk/socialjustice/ethics\\_consultation/films/](https://www.dur.ac.uk/socialjustice/ethics_consultation/films/) (Navigate to the bottom of the page)
- Centre for Social Justice and Community Action and National Coordinating Centre for Public Engagement (2012) Community-based participatory research: A guide to ethical principles and practice, Bristol, NCCPE, [https://www.dur.ac.uk/socialjustice/ethics\\_consultation/ethics.guide/](https://www.dur.ac.uk/socialjustice/ethics_consultation/ethics.guide/)
- Banks, S et al (2013), Everyday ethics in community-based participatory research. Contemporary Social Science: Journal of the Academy of Social Sciences 8(3): 263-277, <http://www.tandfonline.com/doi/abs/10.1080/21582041.2013.769618#.VMDNaE-hTIU>
- Ethics in community-based participatory research, materials on Centre for Social Justice and Community Action website. [https://www.dur.ac.uk/socialjustice/ethics\\_consultation/](https://www.dur.ac.uk/socialjustice/ethics_consultation/)

#### Optional Resources

- Flicker, S. et al (2007), Ethical Dilemmas in Community-Based Participatory Research: Recommendations for Institutional Review Boards. Journal of Urban Health, 84(4), pp. 478-93. <http://web.b.ebscohost.com.ezproxy.library.uvic.ca/ehost/results?vid=0&sid=443f8b11-7acb-43eb-8a18-170474b78a3d%40sessionmgr103&bquery=PM+17436114&bdata=JmRiPW1uaCZ0eXBIPTEmc2l0ZT1laG9zdC1saXZlJnNjb3BIPXNpdGU%3d>
- Smith, L. (2006), Articulating an Indigenous Research Agenda. In Decolonizing Methodologies, Ch. 7, pp. 123-141. UVic call number: GN380 S65. Online readable version <https://ebookcentral.proquest.com/lib/uvic/reader.action?docID=1426837&ppg=212>
- Gov. of Canada (2015), Ethical Guidelines for Research Involving the First Nations, Inuit and Metis Peoples of Canada. <http://www.pre.ethics.gc.ca/eng/policy-politique/initiatives/tcps2-eptc2/chapter9-chapitre9/>

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## MODULE 3

### Steps in CBPR

#### Required Resources

- PRIA (1982), Participatory Research: An Introduction. [https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod\\_folder/content/0/M6%20-%20PRIA\\_1982%20-%20Participatory%20Research%20An%20Introduction.pdf](https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod_folder/content/0/M6%20-%20PRIA_1982%20-%20Participatory%20Research%20An%20Introduction.pdf)
- PRIA (2000), Doing Research with People: Approaches to Participatory research- An Introduction. [https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod\\_folder/content/0/M6%20-%20PRIA\\_2000%20-%20Approaches%20to%20PR.pdf](https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod_folder/content/0/M6%20-%20PRIA_2000%20-%20Approaches%20to%20PR.pdf)
- UNESCO Chair CBR-SR (2017). Guidelines for Field Study. Mentor Training Program 2018.

### Modes of Inquiry

#### Required Resources

- Finley, S. (2008) Arts-Based Research in Knowles, Gary and Ardra Cole (eds.) Handbook of the Arts in Qualitative Research. Sage: Thousand Oaks, CA pp 71-82. [https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod\\_folder/content/0/M7%20-%20Finley\\_2008%20-%20Arts-Based-Research.pdf](https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod_folder/content/0/M7%20-%20Finley_2008%20-%20Arts-Based-Research.pdf)
- Clover, D. (2017) Arts-Based Research (Power Point presentation). [https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod\\_folder/content/0/M7%20-%20Clover\\_2017%20-%20Arts%20based%20research.ppt](https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod_folder/content/0/M7%20-%20Clover_2017%20-%20Arts%20based%20research.ppt)
- PRIA (1992), Participatory Rural Appraisal: Old wines... [https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod\\_folder/content/0/M7%20-%20PRIA%20-%20PRA.pdf](https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod_folder/content/0/M7%20-%20PRIA%20-%20PRA.pdf)
- Corbett, J., and Lydon, M. (2014), Community-Based Mapping: A Tool for Transformation. In C. Etmanski et al. (eds.), Learning and Teaching Community Based Research. U of T Press: Toronto, pp. 113-134 <http://ezproxy.library.uvic.ca/login?url=http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=704528>
- Tremblay, C., & Jayme, B. (2015), Co-creating community knowledge through Participatory Video. Journal of Action Research: Special edition on Knowledge Democracy, 13(3), pp. 298-314. <http://journals.sagepub.com/ezproxy.library.uvic.ca/doi/full/10.1177/1476750315572158>
- Sitter, K. (2017), Taking a Closer Look at Photovoice as a Participatory Action Research Method. Journal of Progressive Human Services, 28 (1), pp. 36-48. <http://www.tandfonline.com/ezproxy.library.uvic.ca/doi/full/10.1080/10428232.2017.1249243>

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Additional resources to be taken up in the face to face workshop as well:

- Kindon, S., Pain, R. and Kesby, M. (2007). Participatory action research approaches and methods: connecting people, participation and place. London: Routledge. Available at: <http://ezproxy.library.uvic.ca/login?url=http://www.tandfebooks.com/isbn/9780203933671>

You will find these and other resources in the Module 7 section

- Tuhiwai, Smith, Linda (2013) Research Through Imperial Eyes in Decolonizing Methodologies London: Zed Books 2013
- Tuhiwai, Smith, Linda (2013) Colonizing Methodologies in Decolonizing Methodologies London: Zed Books |

## MODULE 4

### Knowledge Mobilization: Representation of Knowledge

#### Resources

The following resources contain examples of different ways that have been used in CBPR to represent co-created knowledge. Use these readings when responding to the **discussion questions**:

- Cole Nussbaumer Knaflie (2015), Storytelling with data, Wiley, Hoboken, NJ. <http://www.storytellingwithdata.com/>
- Patel, S. (2007), Reflections on Innovation, Assessment and Social Change Processes: A SPARC case study, India. <https://www.ids.ac.uk/files/dmfile/CasestudySPARC.pdf>
- Research dissemination videos:
  - [https://www.youtube.com/watch?v=A1FO42fO-\\_8](https://www.youtube.com/watch?v=A1FO42fO-_8)

<https://www.youtube.com/watch?v=6zgSgLTs2hI>

### Building & sustaining research partnerships

#### Required Resources

- Rethinking Research Partnerships collaboration (2017). Rethinking Research Partnerships: Discussion Guide and Tool Kit. From Christian Aid's centre of excellence for research, evidence and learning. <https://www.christianaid.org.uk/resources/about-us/rethinking-research-partnerships>
- Wilson, S. (2008), 'Relational Accountability'. In Research is Ceremony: Indigenous Research Methods. Halifax: Fernwood Publishing. UVic call number GN380 W554 2008 [https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod\\_folder/content/0/M12%20-%20Wilson\\_2008\\_Research%20is%20Ceremony.pdf](https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod_folder/content/0/M12%20-%20Wilson_2008_Research%20is%20Ceremony.pdf)

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### Additional Suggested Resource

- Brown, D. L. et al. (2001). Practice-Research Engagement Principles for Civil Society. In D. Brown (ed.), Practice-Research Engagement and Civil Society: In a Globalizing World, Harvard University & CIVICUS, pp 31-48. <http://siteresources.worldbank.org/INTPCENG/1220158-1118058516777/20526704/D87D671E-CDE9-11D5-857B0002A56B5CBF.pdf>

### Reflections from face-to-face component

#### Required Resources

- Small, D. (2005). Reflections of a Feminist Political Scientist on Attempting Participatory Research in Aotearoa. In R. Tandon, R. (ed.), Participatory Research: Revisiting the Roots. New Delhi: Mosaic Books, pp. 74-89. [https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod\\_folder/content/0/M10%20-%20Small\\_2005%20-%20Feminist%20Participatory%20Research%20in%20Aotearoa.pdf](https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod_folder/content/0/M10%20-%20Small_2005%20-%20Feminist%20Participatory%20Research%20in%20Aotearoa.pdf)
- Tandon, R. (2005). Dialogue. In R. Tandon, R. (ed.), Participatory Research: Revisiting the Roots. New Delhi: Mosaic Books, pp. 275-294. [https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod\\_folder/content/0/M10%20-%20Tandon\\_2005%20-%20Dialogue.pdf](https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod_folder/content/0/M10%20-%20Tandon_2005%20-%20Dialogue.pdf)
- Guhathakurta, M. (2008). Theatre in Participatory Action Research: Experiences from Bangladesh. In P. Reason

## MODULE 5

### Balancing Theory & Practice

#### Required Reading

- Bell, B., Gaventa, J., & Peters, J. (eds.) (1987), We Make the Road by Walking: Conversation on Education and Social Change by Myles Horton and Paulo Freire. Temple University Press, Philadelphia, pp 97-101. [https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod\\_folder/content/0/M15%20-%20Bell%20et%20al\\_1987\\_We%20Make%20the%20Road.pdf](https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod_folder/content/0/M15%20-%20Bell%20et%20al_1987_We%20Make%20the%20Road.pdf)

#### Additional suggested resource

- Houh, E., and Kalsem, K. (2015), Theorizing Legal Participatory Action Research: Critical Race/Feminism and Participatory Action Research. Qualitative Inquiry, 03/2015, 21(3), pp. 262-276. <http://journals.sagepub.com.ezproxy.library.uvic.ca/doi/full/10.1177/1077800414562897>
- Blencowe C. et al. (2015), Theorising participatory practice and alienation in health research: A materialist approach. Social Theory & Health, August 2015, 13(3-4), pp 397-417. <https://link-springer-com.ezproxy.library.uvic.ca/article/10.1057%2Fsth.2015.23>
- Wallerstein, N., and Duran, B. (2010), Community-based participatory research contributions to intervention research: the intersection of science and practice to improve health equity. American Journal of Public Health, 04/2010, 100(S1), pp. S40-

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S46. <http://web.b.ebscohost.com.ezproxy.library.uvic.ca/ehost/results?vid=0&sid=3aeda394-bceb-4407-bbaf-4d98919d1b2e%40sessionmgr103&bquery=PM+20147663&bdata=JmRiPW1uaCZ0eXBIPTEmc2l0ZT1laG9zdC1saXZlJnNjb3BIPXNpdGU%3d>

## Field study Impact Assessment

### Required Resources

- Singh, W. (2017), Gauging the Impact of Community University Engagement Initiatives in India. ASEAN Journal of Community Engagement, Vol. I (1), pp. 1-16. <https://dspace.library.uvic.ca//handle/1828/8320>
- Lecture (video recorded): Dr. Crystal Tremblay, Special Advisor on **Engaged Scholarship to the Provost at the University of Victoria**.

If you are having trouble viewing this video, please use the following links (note: please watch all three parts): **Part 1**, **Part 2** and **Part 3**.

- Bowman, S. (2016). Maximising impact through engaged research. Campus Engage. <http://www.columbusproject.eu/SarahBowman.pdf>
- Piggot-Irvine, E., & Zornes, D. (2016). Developing a Framework for Research Evaluation in Complex Contexts Such as Action Research. Sage Open, 1-15. <http://journals.sagepub.com/doi/pdf/10.1177/2158244016663800>
- Tremblay, C., & Jayme, B. (2015). Co-creating community knowledge through Participatory Video. Journal of Action Research: Special edition on Knowledge Democracy, 13(3): 298-314. <http://journals.sagepub.com/doi/abs/10.1177/1476750315572158>
- Tremblay, C. (2017). Impact Assessment of Community-engaged Research at the University of Victoria. Prepared for the Office of the Vice President Research. <https://www.uvic.ca/ocue/assets/docs/CER.UVic.Report.pdf>
- Bagelman, C. & Tremblay, C. (2017). Where pedagogy and social innovation meet: assessing the impact of experiential education in the third sector. In: Osman & Hornsby "Transforming Higher Education: Towards a Socially Just Pedagogy". Palgrave Macmillan. [https://link.springer.com/chapter/10.1007/978-3-319-46176-2\\_11](https://link.springer.com/chapter/10.1007/978-3-319-46176-2_11)
- A Toolkit for Monitoring and Evaluating Children's Participation. Plan International. Source: <https://plan-international.org/publications/monitoring-and-evaluating-childrens-participation>
- Janzen, R., Ochocka, J., Stobbe, A. (2016). Towards a Theory of Change for Community-based Research Projects. Engaged Scholar Journal, 2(2): 44-64. Available at: <http://esj.usask.ca/index.php/esj/article/view/165/37>
- Chong, J., Gero, A., & Treichel, P. (2015). What indicates improved resilience to climate change? A learning and evaluative process developed from a child-centered, community-based project in the Philippines. In D. Bours, C. McGinn, & P. Pringle (Eds.), Monitoring and evaluation of climate change adaptation: A review of the landscape. New Directions for

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Evaluation, 147, 105–116.

<https://onlinelibrary.wiley.com/doi/pdf/10.1002/ev.20134>

#### Additional suggested resources

- UNDP (2013). Discussion Paper Innovations in Monitoring & Evaluating Results. [http://www.undp.org/content/dam/undp/library/capacity-development/English/Discussion%20Paper-%20Innovations%20in%20Monitoring%20&%20Evaluating%20Results%20%20\(5\).pdf](http://www.undp.org/content/dam/undp/library/capacity-development/English/Discussion%20Paper-%20Innovations%20in%20Monitoring%20&%20Evaluating%20Results%20%20(5).pdf)
- PRIA (2001), Participatory Planning, Monitoring & Evaluation. <http://122.160.240.198/gsd/collect/1partici/index/assoc/HASH7b31.dir/doc.pdf>
- Tremblay C. (2017), Impact Assessment. Community-engaged Research (CER) at the University of Victoria, 2009-2015. At <http://hdl.handle.net/1828/8166>

### Reflections on Process of CBPR from Field Study

#### Required Resources

- Kolb, D. A (1984). Experiential learning: experience as the source of learning and development (Chapters 8), First edition. [https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod\\_folder/content/0/M18%20-%20Kolb\\_1984\\_Ch.8.pdf](https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod_folder/content/0/M18%20-%20Kolb_1984_Ch.8.pdf)
- Kolb, D. A (2015). Experiential learning: experience as the source of learning and development (Chapters 2), Second edition. [https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod\\_folder/content/0/M18%20-%20Kolb\\_2015\\_Ch.2.pdf](https://distance.moodle.uvcs.uvic.ca/pluginfile.php/165141/mod_folder/content/0/M18%20-%20Kolb_2015_Ch.2.pdf)
- Online Discussion | Knowledge Mobilization Guide

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# **Centre For Women's Studies.**

*Pt. RavishankarShuklaUniversity, Raipur (C.G.)*

## **Syllabus**

### **Women, Law & Gender Justice 2021-22**

#### **Part – I Theory**

##### **Unit - I**

Basic concept : Sex, Gender, Femininity, Masculinity, Androgyny, Sexually, Discrimination and Women Empowerment.

Feminism : Concept and Meaning, Feminism in India, Development and Feminist Development theory.

Constitution of India and the Gender question : Fundamentals rights, Directive Principles of state policy and Fundamental duties.

##### **Unit II**

Women Human Right : Historical background, UN Conference and Convention on women Need and Principles of Women's Rights. Natural rights of a girl child.

Law : Concept and Importance. Judicial System RTI,PIL,Legal Aid for women in India Family Court.

##### **Unit III**

Law for women in India : Marriage laws : Special marriage Act, 1954, Muslim Personal Law (shari) application Act., 1937, Prohibition of Child Marriage act, 2006.

Divorce Law : Judicial Separation, Divorce and Maintenance (Hindu and Muslim) OPC section 125.

##### **Unit IV**

Property Right and Women : Right to succession and inheritance (Hindu and Muslim Law).

Medical Termination of Pregnancy Act.1971, PCPNDT Act, 2000, Prevention of Sexual Harassment of Women in Work place.The indecent – representation of women (Prohibition) Act, 1986, Domestic Violence Act, 2005.



Anti Rap Law ( latest criminal amendment act 2012)

Adoption laws in India.

Surrogacy laws in India.

Status of single female parent at the time of adoption.

Succession Act. etc

### **Unit – V**

1. National and State Commission of Women : Role & Responsibilities.
2. Women's contribution in Policy Making and Leadership in Women.
3. Understanding women's issues in Panchyati Raj
4. Gender budgeting.

## **Part II**

### ***Project work :***

**PT. RAVISHANKAR SHUKLA UNIVERSITY**  
**RAIPUR - 492010**



DEGREE OF  
**BACHELOR OF VOCATION (B.Voc.)**  
IN  
**RENEWABLE ENERGY TECHNOLOGY & MANAGEMENT**  
**SCHEME AND SYLLABUS**  
UNDER THE  
**FACULTY OF TECHNOLOGY**  
SYLLABUS

(FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2020 - 21 ONWARDS)

PT. RAVISHANKAR SHUKLA UNIVERSITY  
RAIPUR - 492010 (C.G.), INDIA

([www.prsu.ac.in](http://www.prsu.ac.in))

**JULY, 2020**



**BACHELOR OF VOCATION**  
**RENEWABLE ENERGY TECHNOLOGY & MANAGEMENT**  
**PROGRAMME STRUCTURE**

YEAR-1 SEMESTER-I								
MODULE CODE	NAME	L	T	P	CREDIT	INTERNAL	EXTERNAL	TOTAL MARKS
<b>GENERAL EDUCATION COMPONENT</b>								
RETM-101	Fundamentals of Electronics	1	1	1	3	20	80	100
RETM-102	Business Communication – I	1	1	1	3	20	80	100
RETM-103	Energy Sources and Energy Scenario	2	1	0	3	20	80	100
RETM-104	Applied Physics	2	1	0	3	20	80	100
<b>SKILL COMPONENT</b>								
RETM-105	Rooftop Solar PV Power Plant Installation-I	2	1	0	3	20	80	100
RETM-106	Rooftop Solar PV Power Plant Installation-II	2	1	0	3	20	80	100
RETM-107	Wind Energy	2	1	0	3	20	80	100
RETM-108	Wind Turbine Generator	2	1	0	3	20	80	100
RETM-109	Laboratory I (Electronics Lab)	0	0	6	3	20	80	100
RETM-110	Laboratory II (Photovoltaic Lab)	0	0	6	3	20	80	100
<b>TOTAL</b>					<b>30</b>	<b>1000</b>		
<b>YEAR-1 SEMESTER-II</b>								
<b>GENERAL EDUCATION COMPONENT</b>								
RETM-201	Environmental Sciences	2	1	0	3	20	80	100
RETM-202	Industrial Electronics and Instrumentation	2	1	0	3	20	80	100
RETM-203	Biomass Mass Power Generation Systems	2	1	0	3	20	80	100
RETM-204	Report Writing	2	1	0	3	20	80	100

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SKILL COMPONENT								
RETM-205	Waste to Energy Conservation Systems	2	1	0	3	20	80	100
RETM-206	Design of Solar PV Power Plant - I	1	1	1	3	20	80	100
RETM-207	Design of Solar PV Power Plant - II	2	1	1	3	20	80	100
RETM-208	Installation and Commissioning of Solar PV Power Plant	2	1	1	3	20	80	100
RETM-209	Laboratory III (Computer lab)	0	0	6	3	20	80	100
RETM-210	Laboratory IV (Renewable Energy lab)	0	0	6	3	20	80	100
<b>TOTAL</b>					<b>60</b>	<b>2000</b>		

YEAR-2 SEMESTER- III								
MODULE CODE	NAME	L	T	P	CREDIT	INTERNAL	EXTERNAL	TOTAL MARKS
<b>GENERAL EDUCATION COMPONENT</b>								
RETM-301	Innovations In Science	2	1	0	3	20	80	100
RETM-302	Applied Mathematics	2	1	0	3	20	80	100
RETM-303	Mechanics & Thermodynamics for Energy Application	2	1	0	3	20	80	100
RETM-304	Electrical Systems	2	1	0	3	20	80	100
<b>SKILL COMPONENT</b>								
RETM-305	Solar PV Power Plant and Components	2	1	0	3	20	80	100
RETM-306	Programming C++/Java	2	1	0	3	20	80	100
RETM-307	Solar Water Pumping System	1	1	1	3	20	80	100
RETM-308	Evaluation and Monitoring for Wind Power Plant	2	1	0	3	20	80	100
RETM-309	Laboratory V (Digital Electronics)	0	0	6	3	20	80	100
RETM-310	Laboratory VI (Renewable Energy lab)	0	0	6	3	20	80	100

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YEAR-2 SEMESTER-IV								
GENERAL EDUCATION COMPONENT								
RETM-401	Energy Management, Auditing and Utilization	2	1	0	3	20	80	100
RETM-402	Power Electronics	2	1	0	3	20	80	100
RETM-403	Control and Embedded Systems	2	1	0	3	20	80	100
RETM-404	Material Science for Energy Applications	2	1	0	3	20	80	100
SKILL COMPONENT								
RETM-405	Solar Thermal Technologies	2	1	0	3	20	80	100
RETM-406	Concentrating Solar Thermal Systems	2	1	0	3	20	80	100
RETM-407	Engineering Drawing	2	1	0	3	20	80	100
RETM-408	Solar Thermal Systems	2	1	0	3	20	80	100
RETM-409	Workshop Practices I/Minor Project	0	0	12	6	0	200	200
<b>TOTAL</b>					<b>60</b>	<b>2000</b>		

YEAR-3 SEMESTER-V								
MODULE CODE	NAME	L	T	P	CREDIT	INTERNAL	EXTERNAL	TOTAL MARKS
GENERAL EDUCATION COMPONENT								
RETM-501	Solar Business Solutions	1	1	1	3	0	100	100
RETM-502	Health and Safety Practices at Project Site	2	1	0	3	20	80	100
RETM-503	Energy in Buildings	2	1	0	3	20	80	100
RETM-504	Energy Modeling & Project Management	2	1	0	3	20	80	100
SKILL COMPONENT								
RETM-505	Energy Efficiency in Electrical Utilities	2	1	0	3	20	80	100
RETM-506	Hydrogen Energy and Fuel Cells	2	1	0	3	20	80	100



RETM-507	Smart and Micro-Grid	2	1	0	3	20	80	100
RETM-508	Energy Efficiency in Thermal Utilities	2	1	0	3	20	80	100
RETM-509	Workshop Practices II	0	0	12	6	0	200	200
<b>YEAR-3 SEMESTER-VI</b>								
<b>GENERAL EDUCATION COMPONENT</b>								
RETM-601	Industrial Training	0	0	20	10	0	350	350
RETM-602	Major Project	0	0	40	20	0	650	650
<b>TOTAL</b>					<b>60</b>	<b>2000</b>		

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### SEMESTER I (CERTIFICATE COURSE)

This course is designed to give you an insight in to the world of renewable energy technologies. You will get a chance to investigate all aspects of renewable energy. In this programme you will explore:

- Solar energy and its thermal and photovoltaic application
- Details of passive solar architecture
- Wind technologies
- Various biomass to energy routes
- Small hydro technologies
- Geothermal, tidal, wave ocean energy technologies
- Hydrogen and fuel cell

#### RETM - 101

#### FUNDAMENTALS OF ELECTRONICS

TOTAL LECTURES REQUIRED: 45

#### LEARNING OBJECTIVES

1. To familiar students to the basic electronics devices and their fundamentals.
2. To enable students to use different electronics devices for different applications.
3. To encourage students to get their hands in the field of semiconductor, as this technology will play a vital role in understanding the concept for generation of various types of energy.

#### UNIT - I

[10 LECTURES]

**Electronics:** Introduction, Applications-Current and Voltage Source, Physics of Semiconductor Materials -Structure of Atom-Energy band gap diagram of Conductors, Semiconductors and Insulators.

#### UNIT - II

[12 LECTURES]

**Semiconductor Diode:** Types of semiconductors - P & N Types - charge carriers -P &N junction theory-VI characteristics -ideal diode-Rectifiers-types of rectifiers- Filters-C, LC and  $\pi$  -

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Regulators – Zener diode -voltage Regulator, Series voltage Regulator Different types of filters- clipping and clamping circuits –LED-7-segment –Photo diode-LDR.

### UNIT - III

[12 LECTURES]

**Transistor:** Amplifying action-transistor configuration:-CB, CE, CC Configurations-comparison-thermal runaway-heat sink- Transistor ratings -Transistor biasing and stabilization –selection of operating point-different biasing circuits.

**FET:** Introduction, Types, construction, operation, characteristics – FET Parameters–Comparison between FET and BJT– JFET, MOSFET – UJT Characteristics, features and Applications.

### UNIT - IV

[11 LECTURES]

**Storage Batteries:** Introduction, Types of Batteriesprimary and Secondary Batteries-Classification of Secondary Batteries base on their Use-Classification of Lead Storage BatteriesBattery lifeand DOD,Battery Charging, State of Charge, Effect of temperature,Battery for Photovoltaic applications, Battery aging, important guidelines.

#### RECOMMENDED REFERENCES:

1. *Basic Electronics and Linear Circuits*, Bhargava, Kulshreshtra & Gupta Tata McGraw-Hill Publishing Ltd. 2007
2. *Applied Electronics*, R S Sedha, S. Chand and Company Ltd. 2008
3. *Principles of Electronics*, V.K. Mehta, S.Chand and Company Ltd.2005
4. *Electronics Service Technology Vol-1*. SajiA.G, Shyam Mohan , Ayodhya publications, 2007
5. *Integrated Electronics*, Jacob Millman and C. Halkias Mill, Tata McGraw-Hill Publishing Ltd. 2008
6. *Science & Technology of Photovoltaics* P Jayrama Reddy, BS Publications ,CRC Press 2010
7. *Solar Electricity Handbook - 2012 Edition: A Simple Practical Guide to Solar Energy - Designing and Installing Photovoltaic Solar Electric Systems*, Michael Boxwell, Greenstream Publishers, 2012
8. *Photovoltaics: Design and Installation Manual*, Solar Energy International, 2012
9. *Solar Electric Handbook: Photovoltaic Fundamentals and Applications*, Solar Energy International, 2012

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**RETM-102**

**BUSINESS COMMUNICATION - I**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVE:**

1. To introduce students to the theory, fundamentals and tools of communication.
2. To develop in them vital communication skills this should be integral to personal, social and professional interactions.
3. To enable students to have firm grounding in English to be able to use it effectively in professional as well as social contexts.
4. To work towards strengthening the learning process of English language so that our graduates can find their feet in the fiercely competitive job market.

**UNIT - I**

**[11 LECTURES]**

**Introducing Professional English:** Theory of Communication, Types and modes of Communication, Oral communication in English, Communication Cycle, Monologue, Dialogue, Group Discussion, Effective Communication/ Mis-Communication, Principles (7C's) of communication, Grapewine communication, English phonology, Intonation patterns in English, Intra-personal, Inter-personal and Group communication, Auxiliaries, Tense and aspect, Interrogative and negative sentences, The positive, Conditionals, Concord, Confusing words, Question tag.

**UNIT - II**

**[12 LECTURES]**

**Vocabulary:** Verbal and Non-verbal (Spoken and Written) Personal, Social and Business, Phrasal Verbs, Idioms, Collocations, Antonyms / Synonyms, One word substitution, Agreement of verb & subject. Written Business Communication: -Email Etiquette, Professional Presentations; Writing Skills:- Documenting, Report Writing, Making notes, Letter writing, Writing a Resume, Writing-Memo, Cover Letter, Quotation, Tender, Do's & Don'ts of précis writing.

**UNIT - III**

**[11 LECTURES]**

**Advanced Communication Skills:** Initiating, Sustaining and Closing a Business Conversation, Selling skills: closing a sale, participating in Business Discussions, Making Formal Speeches,

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Diction and pronunciation, Agreeing and Disagreeing in Industry, Appointments and Friendly Reminders, Making and Handling Complaints

#### UNIT - IV

[11 LECTURES]

**Internet Communications Skills:** Drafting business e-mails, attending to queries, Email etiquette, Writing blogs and articles, Presentation Techniques including making power point presentations, Group Discussions, Situational Role Play.

#### RECOMMENDED READINGS:

1. *Fluency in English - Part II*, Oxford University Press, 2006.
2. *Business English*, Pearson, 2008.
3. *Language, Literature and Creativity*, Orient Blackswan, 2013.
4. *Language through Literature (forthcoming)* ed. Dr. Gauri Mishra, Dr. Ranjana Kaul, Dr Brati Biswas.
5. Department of Humanities and Social Sciences, Anna University, 'English for Engineers and Technologists', Vols. I & II (Combined Edition), Orient Longman Pvt. Ltd., 2006.
6. LALA, PUSHPA and Sanjay Kumar. 'Communicate or collapse: a handbook of effective public speaking, group discussions and interviews'. PHI Learning Pvt. Ltd., 2007.
7. H.M.Prasad, 'How to prepare for Group Discussion and Interview'. Tata McGrawHill, 2001.
8. Career Press Editors, '101 Great Resumes', Jaico Publishing House, 2003.
9. R.S. Aggarwal, 'A Modern Approach to Verbal & Non-Verbal Reasoning', S.Chand & Co., 2004.
10. Mishra Sunita and Muralikrishna, 'Communication Skills for Engineers', 1<sup>st</sup> Edition, Pearson Education, 2004.



**RETM - 103**

**ENERGY SOURCES AND ENERGY SCENARIO**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. To understand the social, economic impacts of various energy sources.
2. To discuss the financial aspects like pricing and reforms of energy sources.
3. To make the students aware about conservation act, security of energy and environment.
4. To understand the vision and policies of government.

**UNIT - I**

**[11 LECTURES]**

**Introduction to Energy:** Definition and units of energy and power, Conversion, Energy terms, calorific value, Forms of energy, Classification of energy sources Quality and concentration of energy sources, Energy and Thermodynamics, Energy parameters, Conservation of energy, Energy flow diagram to the earth, Origin of fossil fuels, Time scale of fossil fuels, Role of energy in economic development and social transformation, Energy security.

**UNIT - II**

**[11 LECTURES]**

**Energy and Growing Economy:** Commercial energy production, Final energy consumption, Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy conservation and its importance, Energy strategy for the future, Energy Conservation Act-2001 and its features.

**UNIT - III**

**[11 LECTURES]**

**Global Energy Scene:** Energy consumption in various sectors, projected energy consumption for the next century, exponential increase in energy consumption, energy resources, coal, oil, natural gas, nuclear power and hydroelectricity, impact of exponential rise in energy consumption on global economy, future energy options.

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UNIT - IV

[12 LECTURES]

**Indian Energy Scene:** Commercial and non-commercial forms of energy, energy consumption pattern and its variation as a function of time, India's Power Scene, Gas-Based Generating Plants, Nuclear Power Programme, urban and rural energy consumption, energy as a factor limiting growth, need for use of new and renewable energy sources, Socio-economic impacts, Rural development, Poverty alleviation, Employment; Security of supply and use, Environmental and ethical concerns, Economical aspects of renewable energy systems vs large hydro and thermal power projects.

**RECOMMENDED REFERENCES:**

1. Bani P. Banerjee, *Energy and the Environment in India*, Oxford University Press, New Delhi.
2. G. D. Rai, *Non-conventional Sources of Energy*, Khanna Publishers, Delhi.
3. Gopalkumar, *Energy Independence Vision of a Hybrid, Unbound Future*, Deep and Deep Publications Pvt. Ltd., New Delhi.
4. D. K. Asthana, Meera Asthana, *Environment Problems and Solutions*, S.Chand and Company Ltd., New Delhi.
5. Abdul Mubeen, M. Emran Khan, M. Muzaffar-ul-Hasan, *Energy and Environment*, Anamaya Publishers, New Delhi.
6. Upender Pandel, M.P.Poonia, *Energy Technologies for Sustainable Development*, Prime Publishing, Ghaziabad (UP).
7. *Renewable Energy Sources and Emerging Technologies*, Kothari D.P. and Singal K. C., New Arrivals - PHI; 2 edition (2011)

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**RETM - 104**

**APPLIED PHYSICS**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. To familiar students to the basic concepts of physics, its laws.
2. To get student squinted with principles of electronic and electrical devices.
3. To introduce the application of physics in the energy systems and to encourage them to use these concepts to develop ideas for renewable energy field.

**UNIT - I**

**[10 LECTURES]**

**Electric Current and Ohm's Law:** Electron Drift Velocity-Charge Velocity and Velocity of Field Propagation- Electric Potential - Conductance and Conductivity- Ohm's Law Resistance in Series- in Parallel-Types of Resistors-Nonlinear - Varistor-Short and Open Circuits- Series Circuit- Equivalent Resistance-Relative Potential-Voltage Divider Circuits.

**UNIT - II**

**[12 LECTURES]**

**Electrostatics:** Static electricity-Absolute and Relative Permittivity of a Medium-Laws of Electrostatics-Electric Field-Electrostatic Induction-Electric Flux and Faraday Tubes-Electric Flux Density - Electric Displacement D-Gauss Law- Poisson and Laplace-Electric Potential and Energy-Potential and Potential Difference-Potential at a Point-Potential of a charged sphere - Equipotential Surfaces - Voltage and Dielectric Strength - Boundary Conditions.

**UNIT - III**

**[11 LECTURES]**

**Electromagnetic Induction:** Relation between Magnetism and Electricity-Production of Induced E.M.F. and Current-Faraday's Laws of Electromagnetic Induction- Lenz's Law Induced E.M.F.- Dynamically-Statically-induced E.M.F.-Self-Inductance-Coefficient of Self Inductance (L)-Mutual Inductance-Coefficient of Mutual Inductance (M)-Coefficient of Coupling-Inductances in Series and Parallel.

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UNIT - IV

[12 LECTURES]

**Magnetic Hysteresis-** Area of Hysteresis Loop Properties and applications of Ferromagnetic Materials-Permanent magnet materials-Steinmetz Hysteresis Law-Energy Stored in Magnetic Field-Rate of Change of Stored Energy- - Lifting Power of Magnet-Rise and Decay of Current in Inductive Circuit- Transient Current Rise and decay R-L Circuit –Automobile Ignition System.

**RECOMMENDED REFERENCES:**

1. *Electrical Technology, Naidu-Kamakshaiyah, Tata McGraw-Hill Education, 2006*
2. *Fundamentals of Electrical Engineering, RajendraPrasad, PHI Learning Pvt. Ltd.,2005*
3. *A Text Book of Electrical Technology, B.L. Theraja, S. Chand Limited, 2008*
4. *Photovoltaics: Design and Installation Manual, Solar Energy International, 2012*

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**RETM - 105**

**ROOFTOP SOLAR PV POWER PLANT INSTALLATION-I**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. To understand the solar radiation on earth surface.
2. To understand the various solar cell parameters
3. The principle of photovoltaic technologies and there characteristics.
4. Estimation of cost of PV Systems.

**UNIT - I**

**[10 LECTURES]**

Location of installation and optimize the route plan, Assess the site level pre-requisites for solar panel installation, Check for any shading obstacles – Carry out on-site and off-site shadow analysis, Decide on the type of mounting to be constructed , Inform the customer for any civil construction to be undertaken for installing the panels.

**UNIT - II**

**[12 LECTURES]**

Prepare a site map of the location where installation has to be carried out , Assess the load to be run on Solar Power Plant , Prepare a load profile, Document the site survey variables and complete the checklist/site survey form, Exposure to and hands-on experience on site survey tools.

**UNIT - III**

**[11 LECTURES]**

Prepare plant layout including component locations, cable routing, interconnection point and metering point, Record interconnection voltage level and system configuration accordingly, Identify limitations and incentives according to relevant applicable policies, regulations and procedures.

**Unit - IV**

**[12 LECTURES]**

Perform the following activities for the irradiation and climate analysis , analyze the daily, monthly and annual solar resource data including GHI, DNI, Albedo etc. for site to evaluate the potential for solar energy generation at the site in consideration.

**RECOMMENDED REFERENCES:**

1. *Interconnection And Inspection Of Grid Connected Rooftop Solar Photovoltaic System: A Guide for DISCOM Engineers and managers*, Tanmay Bishnoi, Ronnie Khanna, Arvind Karandikar, Deepanker Bishnoi, Taylor & Francis (2019).
2. *Evaluation of Solar Proposals: A Guide for financial institutions, Solar Developers & EPCs, , Skill Council for Green Jobs*, Taylor & Francis (2019).
3. *Greening the Roofs: A Guide for Solar Entrepreneurs*, Tanmay Bishnoi, Ronnie Khanna, Arvind Karandikar, Deepanker Bishnoi, Taylor & Francis (2019).
4. *Renewable Energy Technologies: A Practical Guide for Beginners*, Chetan Singh Solanki, PHI School Books (2008)
5. *Solar Photovoltaics: Fundamentals, Technologies and Applications*, Chetan Singh Solanki PHI; 3 edition 2015
6. *Renewable Energy Sources and Emerging Technologies*, Kothari D.P. and Singal K. C, New Arrivals - PHI; 2 edition (2011)
7. *Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers*, Chetan Singh Solanki PHI (1 January 2013)
8. *Fundamentals of Renewable Energy Systems Paperback – D. Mukherjee*, New Age International Publisher; First edition (2011)
9. *Science & Technology of Photovoltaics* P Jayrama Reddy, BS Publications ,CRC Press 2010.
10. *From Sunlight to Electricity: A Practical Handbook on Solar Photovoltaic Applications*, Suneel Deambi, The Energy and Resources Institute, TERI (30 January 2009)



**RETM-106**

**ROOFTOP SOLAR PV POWER PLANT INSTALLATION-II**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. To understand the solar radiation on earth surface.
2. To understand the various solar cell parameters
3. The principle of photovoltaic technologies and there characteristics.
4. Estimation of cost of PV Systems.

**UNIT - I**

**[12 LECTURES]**

Collection of data on local weather conditions such as temperature range, flooding , wind speed, humidity, pollution levels, snow and other climatic conditions for assessment of its impact on solar energy generation.

**UNIT - II**

**[12 LECTURES]**

Assess the ground water availability and quality, load bearing capacities, pH levels and seismic risk , Perform the soil analysis while ensure conducting of soil testing like soil resistivity, dust percentage, soil strength, etc. as per requirement . Perform the following activities for contour mapping: prepare a detailed survey plan of the land proposed for installation of solar power plant with elevations and topography – contour mapping.

**UNIT - III**

**[12 LECTURES]**

Calculate the exact land area of the proposed site where installation is to be commenced , carry out far shading and near shading analysis and map the usable area for solar installation, ensure identification of accessibility of the site i.e. its connectivity to various transport mechanisms including rail, road, connecting roads, etc. assess grid availability for power evacuation including nearest substation and transmission line capacity as well as distance from project site, ensure compilation of all the data arrived from the analysis done and present to the concerned senior authority.



**UNIT - IV**

**[09 LECTURES]**

Solar Installation - analyse environmental and social impact of the plant and the risks involved at the site like insect infestation or wild animals, Identify local support and hindrance factors and include in the report as a special section for any site-specific restrictions, Identify limitations and incentives according to relevant applicable policies, regulations and procedures.

**RECOMMENDED REFERENCES:**

1. *Interconnection And Inspection Of Grid Connected Rooftop Solar Photovoltaic System: A Guide for DISCOM Engineers and managers*, Tanmay Bishnoi, Ronnie Khanna, Arvind Karandikar, Deepanker Bishnoi, Taylor & Francis (2019).
2. *Evaluation of Solar Proposals: A Guide for financial institutions, Solar Developers & EPCs*, Skill Council for Green Jobs, Taylor & Francis (2019).
3. *Greening the Roofs: A Guide for Solar Entrepreneurs*, Tanmay Bishnoi, Ronnie Khanna, Arvind Karandikar, Deepanker Bishnoi, Taylor & Francis (2019).
4. *Renewable Energy Technologies: A Practical Guide for Beginners*, Chetan Singh Solanki, PHI School Books (2008)
5. *Solar Photovoltaics: Fundamentals, Technologies and Applications*, Chetan Singh Solanki PHI; 3 edition 2015
6. *Renewable Energy Sources and Emerging Technologies*, Kothari D.P. and Singal K. C, New Arrivals - PHI; 2 edition (2011)
7. *Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers*, Chetan Singh Solanki PHI (1 January 2013)
8. *Fundamentals of Renewable Energy Systems Paperback* - D. Mukherjee, New Age International Publisher; First edition (2011)
9. *Science & Technology of Photovoltaics* P Jayrama Reddy, BS Publications, CRC Press 2010.
10. *From Sunlight to Electricity: A Practical Handbook on Solar Photovoltaic Applications*, Suneel Deambi, The Energy and Resources Institute, TERI (30 January 2009)

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**RETM-107**

**WIND ENERGY**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. Awareness about Wind Energy.
2. Understanding the design considerations of Wind projects.
3. Awareness about global scenario & current status.
4. Get acquainted to various types of Wind power stations.

**UNIT - I**

**[12 LECTURES]**

Perform the following activities to do the wind resource analysis: analyse detailed site information, analyse the daily, monthly and annual wind resource data of site to evaluate the potential for wind energy generation, ensure the collection of data on local weather conditions such as temperature range, flooding (in case of onshore), wind speed, humidity, rainfall and assess its impact on wind energy generation, assess the ground water availability and quality, load bearing capacities.

**UNIT - II**

**[12 LECTURES]**

Wind Energy- pH levels and seismic risk, analyse the pre-site selection baseline data for project execution suitability identify location for Power Curve test, ensure installation of meteorological mast (met mast) at site, analyse wind data collected from met mast for wind potential.

**UNIT - III**

**[12 LECTURES]**

Perform the contour mapping - prepare a detailed survey plan of the land proposed for installation of wind power plant with elevations and topography, calculate the exact land area of the proposed site where installation is to be commenced, prepare contour map of proposed wind plant site, conduct field surveys and give site ranking.

*G. K. Singh*  
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UNIT - IV

[09 LECTURES]

**Wind energy systems:** Environment and Economics Environmental benefits and problems of wind energy, Economics of wind energy

**Factors influence the cost of energy generation:** Site specific parameters, machine parameters, Life cycle cost analysis, Wind electric generators, Tower, rotor, gearbox, power regulation, safety mechanisms, Generator: Induction and synchronous generator, Grid integration, Wind pumps, Wind driven piston pumps, limitations, and performance analysis.

**RECOMMENDED REFERENCES:**

1. *Freris L.L: Wind Energy Conversion Systems, Prentice Hall*
2. *Brendan Fox: Wind power integration : connection and system operational aspect*
3. *Frede Blaabjerg, Zhe Chen: Power electronics for modern wind turbines*
4. *Olimpo Anaya-Lara: Wind energy generation : modelling and control*

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**RETM-108**

**WIND TURBINE GENERATOR**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. Awareness about various wind turbines.
2. Understanding the design considerations of Wind projects.
3. Awareness about global scenario & current status.
4. Get acquainted to various types of Wind power stations.

**UNIT - I**

**[12 LECTURES]**

Identify position of WTG, substation, transmission line, transformers, etc. physical site accessibility, identify accessibility of the site i.e., its connectivity to various transport mechanisms including rail, road, connecting roads etc., ensure conducting of route survey, identify soil type and its strength, identify state/central law of land leasing and purchase.

**UNIT - II**

**[12 LECTURES]**

Transmission line & grid availability analysis: assess grid availability for power evacuation including nearest substation and transmission line capacity, identify the relevant grid authority, check the feasibility of point of power evacuation

**UNIT - III**

**[12 LECTURES]**

Report preparation, validate collected wind data from site, verify the wind potential with other resources such as NREL/ATLAS, prepare detailed site survey report using GPS/DGPS and wind data analysis software.

**UNIT - IV**

**[09 LECTURES]**

Analyse environmental and social impact of the plant and site risk analysis, Identify local support and hindrance factors and include in the report as a special section, Identify limitations and incentives according to relevant applicable policies, regulations and procedures

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*H. B. Tewari*

*J. S. Singh*

**RECOMMENDED REFERENCES:**

1. *Freris L.L: Wind Energy Conversion Systems, Prentice Hall*
2. *Brendan Fox: Wind power integration : connection and system operational aspect*
3. *Frede Blaabjerg, Zhe Chen: Power electronics for modern wind turbines*
4. *Olimpo Anaya-Lara: Wind energy generation : modelling and control*

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**RETM-109**

**LABORATORY -I**

**[ELECTRONICS LAB]**

1. To identify the connection & component testing.
2. Study of Forward Characteristics of Silicon diode.
3. Study of Reverse Characteristics of Germanium Diode.
4. Study of characteristics of Zener diode
5. Study of Characteristics of Light Emitting Diode (LED)
6. Study of Half-wave Rectifier
7. Study of Full-wave Center-tapped Rectifier
8. Study of Full-wave Bridge Rectifier
9. To calculate the Ripple Factor and Efficiency of various Rectifiers
10. Study of Zener Diode as a voltage regulator, when input voltage,  $V_{in}$  is fixed while load resistance,  $R_L$  is variable.
11. Study of Zener diode as a voltage regulator, when input voltage,  $V_{in}$  is variable while load resistance,  $R_L$  is fixed.
12. Study of Characteristics of SCR and plotting V-I Characteristics.
13. To determine the characteristics of transistor for both PNP & NPN in Common Emitter Configuration
14. To examine the relationship between the Gate to Source voltage ( $V_{GS}$ ) drain current ( $I_D$ ) and the Drain to Source voltage ( $V_{DS}$ ) in an N-channel junction FET and measure the corresponding values & plot these values to form a set of drain characteristics curves.
15. To examine the relationship between the Gate to Source voltage ( $V_{GS}$ ) drain current ( $I_D$ ) and the Drain to Source voltage ( $V_{DS}$ ) in an N-channel depletion mode IGFET and measure the corresponding values & plot these values to form a set of drain characteristic.
16. To study characteristics of Low pass filter.
17. To study characteristics of High pass filter.
18. To study characteristics of Band pass filter.
19. To study characteristics of Notch filter.



**RETM-110**

**LABORATORY -II**

**[PHOTOVOLTAIC LABORATORY]**

1. To demonstrate I-V and P-V characteristics of single solar cell of PV module in field.
2. To demonstrate I-V and P-V characteristics of series and parallel combinations of PV module in field.
3. To measure I-V and P-V characteristics of a single solar cell at constant intensity using mini solar simulator.
4. To measure I-V and P-V characteristics of a solar cell in series and parallel combination at constant intensity using mini solar simulator.
5. To measure I-V and P-V characteristics of a single solar cell at variable intensities using mini solar simulator.
6. To measure I-V and P-V characteristics of a solar cell in series and parallel combination at variable intensities using mini solar simulator.
7. To measure I-V and P-V characteristics of a single solar cell at constant intensity using solar simulator.
8. To measure I-V and P-V characteristics of a solar cell in series and parallel combination at constant intensity using solar simulator.
9. To measure I-V and P-V characteristics of a single solar cell at variable intensities using solar simulator.
10. To measure I-V and P-V characteristics of a solar cell in series and parallel combination at variable intensities using solar simulator.
11. To measure I-V and P-V characteristics of a single solar cell at variable temperature & fixed intensity using solar simulator.
12. To measure I-V and P-V characteristics of a solar cell in series and parallel combination at variable temperature & fixed intensity using solar simulator.
13. To measure the spectral response of a solar cell and to learn about quantum efficiency.
14. Study I-V characteristics of solar panel at different tilt angles
15. Study of the parameters of Series and parallel connection of solar panels at different tilt and Seasonal angles
16. To demonstrate the effects of radiant energy on LDR & to show how radiant energy on LDR can be used to control electronic circuits.
17. Evaluate  $U_L$  (Heat loss coefficient) of solar thermal kit in thermo-symphonic mode of flow with fixed input parameters.



**SEMESTER II (DIPLOMA COURSE)**

**RETM - 201**

**ENVIRONMENTAL STUDIES**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. To familiarize students to the basic concepts of environmental studies.
2. To help students develop their own perspectives around environmental issues.
3. To enable students to take practical steps to conserve the environment.

**UNIT - I**

**[12 LECTURES]**

**Environment:** Definition and Composition - Lithosphere, Hydrosphere, Atmosphere, Biosphere, Hydrological Cycle, Historical Development and Approaches, Man and Nature relation and interaction with respect to Food, Clothing, Shelter and Occupation, Concept of Ecology and Ecosystem.

**UNIT - II**

**[12 LECTURES]**

**Resources and Wealth:** Meaning, Types of Resources, Exploitation of Resources, use of Technology and its Impact on Natural Environment, Wealth – meaning, Distinction between wealth and resources, Optimum Conversion of Resources into wealth, Anthropogenic Waste – its effects, Man-made Industrial waste.

**UNIT - III**

**[12 LECTURES]**

**Environmental Degradation:** Meaning, Causes: Degradation of Urban Land, Forest and Agricultural Land due to natural causes and human interference, Global Warming: Problems of non-degradable Waste – Electronic Devices, Plastic and Man - made fibres, Environmental Assessment – Environmental Impact Assessment (EIA), Environmental Auditing and Environmental Legislation in India, Carbon Bank.

**UNIT - IV**

**[09 LECTURES]**

**Environmental Management:** Meaning, development and environmental linkages, Environmental concerns in India. The need for sustainable development, Actions for

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environmental Protection: national and international initiatives, emerging environment management strategies, Indian initiatives, Environmental Protection Movements and NGOs in India.

**RECOMMENDED REFERENCES:**

1. R. Rajagopalan, R. (2005) *Environmental Studies – From Crisis to Cure*. Delhi: OUP.
2. Guha Ramachandra *Environmentalism: A global history (OUP) (2000)*

G. K. Singh  
18-1-2020

H. S. Singh

R. K. Singh



RETM - 202

INDUSTRIAL ELECTRONICS & INSTRUMENTATION

TOTAL LECTURES REQUIRED: 45

LEARNING OBJECTIVES

1. To familiarize with the characteristics of instruments.
2. To familiarize with the properties of transducer.
3. To understand the fundamentals of amplifiers & OPAMP's.

UNIT - I

[12 LECTURES]

**Performance Characteristics of Instrument:** Need of measurement, Classification of electronic instruments, Selection of Instruments, Static characteristics: Accuracy, Resolution, Precision, Expected value. **Instruments:** Solar radiation Measurement; Lux Meter, Pyrheliometer, Pyranometer, Sunshine Recorder, wind speed measurement anemometer, Temperature measurement, Pressure, velocity and flow measurement, Heat flux measurement.

UNIT - II

[11 LECTURES]

**Transducers:** Principles and classification of transducers, basic requirements of transducers, displacement, strain gauge, LVDT & RVDT, potentiometer, capacitive & inductive, Temperature Transducer - Resistance Temperature Detector (RTD), Thermistor, Thermocouple, Piezo-electric transducer, Optical Transducer- Photo emissive, Photo conductive, Photo voltaic, Photo-diode, Photo Transistor.

UNIT - III

[11 LECTURES]

**Feedback Amplifiers:** Classification: Feedback concept; Ideal Feedback amplifier: Properties of Negative Feedback Amplifier Topologies: Method of Analysis of Feedback amplifiers: Voltage series Feedback: Voltage series Feedback pair: Current series, Current shunt and Voltage shunt feedback; Effect of feedback on amplifier Bandwidth and stability.

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UNIT - IV

[11 LECTURES]

**Operational Amplifier:** Idea of operational amplifier (OP-AMP), Ideal OPAMP as black box, input and output impedance, OPAMP circuits as buffer, inverting and non-inverting amplifiers, adder and subtractor. **Signal Generators & Conditioners:** Square Wave Generator, Triangular Wave Generator, Sawtooth Wave generator, Differentiator & Integrator.

**RECOMMENDED REFERENCES:**

1. *A Course in Electrical and Electronic Measurements and Instrumentation*, A. K Sawhney, Dhanpat Rai & Co.
2. *Electronic Instrumentation & Measurement* by William Cooper & Albert C. Helfric, PHI Pub.
3. *Instrumentation, Measurement & Analysis* by K.K. Chaudhury & R.C. Nakra, TMH.
4. *OP-AMP and linear integrated circuits 2nd edition*, PLHI by Ramakant A. Gayakwad.
5. *Integrated Electronics* by Millman & Halkias, TMH Publishing Co.
6. *Electronic Instrumentation*, H S Kalsi, Tata McGraw-Hill Education.
7. *Instrumentation Devices and Systems*, C.S. Rangan, Tata McGraw-Hill Education.

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18-1-2020

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R. C. Nakra



**RETM - 203**

**BIOMASS POWER GENERATION SYSTEMS**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVE**

The course develops necessary understanding on the biomass of energy materials. It is specifically designed to empower non-biology background students with necessary knowledge and very important concepts of biomass. Student will acquire understanding at the molecule level as well as at the bulk material level.

**UNIT - I**

**[14 LECTURES]**

Biomass- Generation and Utilization, Properties of biomass, Agriculture crop and forestry residues and as fuels, Biochemical and Thermo chemical conversion, combustion, Gasification, Biomass gasifiers and types etc, Biomass as a decentralized power generation source for villages.

**UNIT - II**

**[12 LECTURES]**

Biomass resource analysis - analyse detailed site information including source of biomass and storage space requirements, if any, Identify the type and quantity of biomass available, Conduct the tests to identify the moisture content, carbon content and calorific value of the biomass available.

**UNIT - III**

**[09 LECTURES]**

Identify pre-production process requirements for each type of biomass, Study present market linkages and data on current practices of use or disposal of biomass, Collect information about the local weather conditions such as temperature range, wind speed, humidity, rainfall and seasonal availability of the resource, assess the ground water availability and, load bearing capacities, pH levels, seismic risk and do a detailed risk analysis for fire accidents.

**UNIT - IV**

**[10 LECTURES]**

Analyse the pre-site selection baseline data for project execution suitability, identify location for Power Curve test, collect and analyse the biomass availability data – check at least 10 years data to establish trends, Identify limitations and incentives according to relevant applicable policies, regulations and procedures.

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**RECOMMENDED REFERENCES:**

1. *Non-Conventional Energy Resources*, B.H. Khan, Tata McGraw-Hill Education (2006).
2. *Renewable Energy Technologies: A Practical Guide for Beginners*, Chetan Singh Solanki, PHI School Books (2008).
3. *Fundamentals of Renewable Energy Systems Paperback – D. Mukherjee*, New Age International Publisher; First edition (2011)
4. *Renewable Energy Sources and Emerging Technologies*, Kothari D.P. and Singal K.C., New Arrivals - PHI; 2 edition (2011)
5. G. D. Rai, *Non- conventional Sources of Energy*, Khanna Publishers, Delhi.

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**RETM - 204**

**REPORT WRITING**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. Understand the research preparation and planning.
2. Understand various data collection methods.
3. Study various sampling methods.
4. Perform various sampling tests.
5. Prepare effective report.

**UNIT - I**

**[12 LECTURES]**

Identify optimum location of installations, assess the site level pre-requisites for solar panel installation, decide on the type of mounting (fixed / tracking system) to be constructed and place of mounting as per client requirement, check for any shading obstacles.

**UNIT - II**

**[12 LECTURES]**

Prepare a site map of the location where installation has to be carried out, assess the load to be run on solar PV power Plant and prepare a load profile, estimate the capacity of solar PV power plant decide on battery backup as per grid availability, loads and client expectation.

**UNIT - III**

**[12 LECTURES]**

Assess or obtain the site specific major parameters of solar resource data like GHI, DNI, Temperature and Wind , perform shading analysis, estimate the energy generated from the rooftop solar PV power plant using solar design software like PV\*SOL®, etc.

**UNIT - IV**

**[9 LECTURES]**

Identify the risks associated with the specific solar project including personnel and plant security analysis , Carry out a cost benefit analysis of using tracking system, prepare a site feasibility study report using specialized software like PV\*SOL®, PVsyst, etc.

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**RECOMMENDED REFERENCES:**

1. *Evaluation of Solar Proposals: A Guide for financial institutions, Solar Developers & EPCs, , Skill Council for Green Jobs, Taylor & Francis (2019).*
2. *Greening the Roofs: A Guide for Solar Entrepreneurs, Tanmay Bishnoi, Ronnie Khanna, Arvind Karandikar, Deepanker Bishnoi, Taylor & Francis (2019).*
3. *Business Correspondence and Report Writing - 1 Jul 2017, R C Sharma, Krishna Mohan*
4. *Better Business Writing , English, Paperback, Brock Susan L.*

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**RETM - 205**

**WASTE TO ENERGY CONVERSION SYSTEMS**

**TOTAL LECTURES REQUIRED: 45**

1. To understand the various waste generation sources and their management.
2. To know the various waste to energy conversion technologies.
3. To understand various impacts like health and environment issues and significance of different technologies.
4. To get acquainted with commercial aspects of waste to energy.

**UNIT - I**

**[10 LECTURES]**

Waste resource analysis- analyse detailed site information, Identify the type and quantity of waste available for incineration , Conduct the tests to identify the moisture content, chemical composition, presence of hazardous material, non-degradable content in waste, carbon content and calorific value of the waste available.

**UNIT - II**

**[11 LECTURES]**

Collect information about the local weather conditions such as temperature range, wind speed, humidity, rainfall and seasonal availability of the resource; assess the ground water availability and its quality, load bearing capacities, pH levels and seismic risk and fire risk analysis.

**UNIT - III**

**[12 LECTURES]**

Analyse and present comparison of different types of technologies for waste to-energy conversion, analyse the pre-site selection baseline data for project execution suitability, identify the load, collect and analyse the waste availability data.

**UNIT - IV**

**[12 LECTURES]**

Identify bi-products and waste from the plant and their disposal arrangements, Environment impact for storage and disposal of waste.

**RECOMMENDED REFERENCES:**

1. Gary C. Young, *Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons*, ISBN: 9780470539675, John Wiley and Sons.

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2. *Velma I. Grover and Vaneeta Grover, Recovering Energy from Waste Various Aspects, ISBN 978-1-57808-200-1.*
3. *Shah, Kanti L., Basics of Solid and Hazardous Waste Management Technology, Prentice Hall.*
4. *Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers.*
5. *Marc J. Rogoff, Waste-to-Energy, Elsevier.*
6. *Parker, Colin and Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London.*
7. *Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House.*
8. *Bhide A. D., Sundaresan B. B., Solid Waste Management in Developing Countries, INSDOC, New Delhi.*

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**RETM - 206**

**DESIGN OF SOLAR PV POWER PLANT-I**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. To understand the various solar cell parameters
2. The principle of photovoltaic technologies and their characteristics.
3. Estimation of cost of PV Systems.

**UNIT I**

**[12 LECTURES]**

Review of structural design of solar PV power plant o review and interpret of the mounting structure and foundation design drawings o review the overall structural layout of the solar PV power plant, prepare the design and selection of solar modules o select solar module technology and size.

**UNIT II**

**[13 LECTURES]**

Analysis of cost, power output, compliance with quality standards, climatic conditions of the site, global and diffused irradiance ratio at the site, warranty terms and conditions, etc. , workout the total numbers of modules based on the total capacity of the plant and the capacity of selected modules,

**UNIT III**

**[10 LECTURES]**

Prepare the earthing design of solar module arrays, prepare the design and selection of inverters, select inverter, based on compatibility with module technology, compliance with grid code and other applicable regulations, reliability, system availability, serviceability, compliance with quality standards, cost.

**UNIT IV**

**[10 LECTURES]**

DC TO AC conversion efficiency o in case of a roof top power plant, decide on specifications of the inverter to power the AC loads in the building o decide on number of inverters to be used based on the capacity and specifications of the inverter selected o finalize the inverter layout and inverter locations on the basis of total capacity o prepare the earthing design of inverters.

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**RECOMMENDED REFERENCES:**

1. *Interconnection And Inspection Of Grid Connected Rooftop Solar Photovoltaic System: A Guide for DISCOM Engineers and managers*, Tanmay Bishnoi, Ronnie Khanna, Arvind Karandikar, Deepanker Bishnoi, Taylor & Francis (2019).
2. *Evaluation of Solar Proposals: A Guide for financial institutions, Solar Developers & EPCs*, , Skill Council for Green Jobs, Taylor & Francis (2019).
3. *Greening the Roofs: A Guide for Solar Entrepreneurs*, Tanmay Bishnoi, Ronnie Khanna, Arvind Karandikar, Deepanker Bishnoi, Taylor & Francis (2019).
4. *Solar Engineering of Thermal Processes*, John A. Duffie, William A. Beckman, John Wiley & sons.
5. *Renewable Energy Sources and Emerging Technologies*, Kothari D.P. and Singal K.C., New Arrivals - PHI; 2 edition (2011)
6. *Solar Energy, Fundamentals, Design, Modelling & Applications*, G.N.Tiwari, Narosa Publishing House.
7. *Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers*, Chetan Singh Solanki, PHI (1 January 2013)
8. *Fundamentals of Renewable Energy Systems-* D. Mukherjee, New Age International Publisher; First edition (2011)
9. *Solar Photovoltaics: Fundamentals, Technologies and Applications*, Chetan Singh Solanki PHI; 3 edition 2015.
10. *From Sunlight to Electricity: A Practical Handbook on Solar Photovoltaic Applications*, Suneel Deambi, The Energy and Resources Institute, TERI (30 January 2009).

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**RETM - 207**

**DESIGN OF SOLAR PV POWER PLANT-II**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. To understand the various solar cell parameters
2. The principle of photovoltaic technologies and their characteristics.
3. Estimation of cost of PV Systems.

**UNIT - I**

**[12 LECTURES]**

Solar PV Power Plant- prepare the design of strings, workout number of modules in a string based on the input voltage and MPPT voltage range of the inverter, workout number of strings connected to a combiner box based on minimum run of DC connecting cables to minimize DC losses

**UNIT - II**

**[10 LECTURES]**

Inter row distance between the solar modules on the basis of minimum inter row shading, adequate space for cleaning and maintenance of solar modules and tilted to south at an angle that optimizes the annual energy yield or specify DC cabling material, size, type of PVC for cables connecting modules, junction boxes to the combiner boxes and combiner boxes to the inverter panels etc.

**UNIT - III**

**[11 LECTURES]**

Prepare the specification of DC connectors (plugs and sockets) to be used, prepare the design and selection of combiner boxes and switchgear, prepare the design specifications for junction boxes/combiner including IP number, prepare the specifications for disconnects/switches, workout number of combiner boxes connected to one panel of the inverter based on the input current rating of the inverter, protect incorrect polarity, overvoltage and overload for the DC cables.

**UNIT - IV**

**[12 LECTURES]**

Selection of batteries for rooftop off grid solar power plant, decide the battery storage capacity (Ah) based on the number of days autonomy required (kWh/Wh) and the depth of discharge of

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the battery bank, Decide the type of battery based on local conditions, market information and cost-economics analysis, decide on the specifications for the charge controller/ inverter to control the overcharging/discharging of the batteries, Warranty terms and conditions o prepare energy generation report using simulation software, Explain and calculate the basic financial analysis like Payback period, Return on Investment, Return on Equity, etc.

**RECOMMENDED REFERENCES:**

1. *Interconnection And Inspection Of Grid Connected Rooftop Solar Photovoltaic System: A Guide for DISCOM Engineers and managers*, Tanmay Bishnoi, Ronnie Khanna, Arvind Karandikar, Deepanker Bishnoi, Taylor & Francis (2019).
2. *Evaluation of Solar Proposals: A Guide for financial institutions, Solar Developers & EPCs, , Skill Council for Green Jobs*, Taylor & Francis (2019).
3. *Greening the Roofs: A Guide for Solar Entrepreneurs*, Tanmay Bishnoi, Ronnie Khanna, Arvind Karandikar, Deepanker Bishnoi, Taylor & Francis (2019).
4. *Renewable Energy Sources and Emerging Technologies*, Kothari D.P. and Singal K. C, New Arrivals - PHI; 2 edition (2011)
5. *Solar Energy, Fundamentals, Design, Modelling & Applications*, G.N.Tiwari, Narosa Publishing House.
6. *Solar Engineering of Thermal Processes*, John A. Duffie, William A. Beckman, John Wiley & sons.
7. *Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers*, Chetan Singh Solanki, PHI (1 January 2013)
8. *Fundamentals of Renewable Energy Systems Paperback* – D. Mukherjee, New Age International Publisher; First edition (2011)
9. *Solar Photovoltaics: Fundamentals, Technologies and Applications*, Chetan Singh Solanki PHI; 3 edition 2015.

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**RETM - 208**

**INSTALLATION AND COMMISSIONING OF SOLAR PV POWER PLANT**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. To understand the various solar cell parameters
2. The principle of photovoltaic technologies and their characteristics.
3. Estimation of cost, installation and commissioning of PV Systems.

**UNIT - I**

**[13 LECTURES]**

Preparation before initiating construction at site, read and interpret the design and detailed drawings of the civil, mechanical and electrical works to be carried out at site, ensure the marking of the complete layout of the plant as per design, arrange for tools and consumables required for installation.

**UNIT - II**

**[10 LECTURES]**

Identify and allocate work items for labour teams and coordinate among the teams for parallel and timely execution of the project, manage the installation schedule, follow the schedule for each of the civil and mechanical construction activities, manage the schedule for installation of modules, inverters, transformers, power protection devices, lightning arresters, earthing systems, ensure installation as per the design documents, ensure the installation of cables between different components including modules, inverter and other components as per design documents, check cables for continuity.

**UNIT - III**

**[12 LECTURES]**

Manage the installation of communication and storage system with SCADA facility/ any monitoring system, Complete all ground / roof related activities like drainage systems, cable trenches identification marking, signages at different locations in the plant, ensure installation of battery banks if required, prepare, review and report progress on daily basis to the site in-charge for further action – through use of project management techniques such as MS Project, etc.,

**UNIT - IV**

**[10 LECTURES]**

Test and commission the solar PV power plant, visually inspect the plant after installation, get pre-connection connectivity and conductivity test done, verify system grounding and get the

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insulation resistance measured , confirm that electrical protections, disconnection and other provisions are fulfilled as per design documents, get the DC voltage and current test done for each of the module strings, measure and record all relevant parameters of energy storage system if present ,confirm smooth functioning of trackers, if any .

**RECOMMENDED REFERENCES:**

1. *Interconnection And Inspection Of Grid Connected Rooftop Solar Photovoltaic System: A Guide for DISCOM Engineers and managers*, Tanmay Bishnoi, Ronnie Khanna, Arvind Karandikar, Deepanker Bishnoi, Taylor & Francis (2019).
2. *Evaluation of Solar Proposals: A Guide for financial institutions, Solar Developers & EPCs, , Skill Council for Green Jobs*, Taylor & Francis (2019).
3. *Greening the Roofs: A Guide for Solar Entrepreneurs*, Tanmay Bishnoi, Ronnie Khanna, Arvind Karandikar, Deepanker Bishnoi, Taylor & Francis (2019).
4. *Renewable Energy Sources and Emerging Technologies*, Kothari D.P. and Singal K. C, New Arrivals - PHI; 2 edition (2011)
5. *Solar Energy, Fundamentals, Design, Modelling & Applications*, G.N.Tiwari, Narosa Publishing House.
6. *Solar Engineering of Thermal Processes*, John A. Duffie, William A. Beckman, John Wiley & sons.
7. *Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers*, Chetan Singh Solanki, PHI (1 January 2013)
8. *Fundamentals of Renewable Energy Systems Paperback - D. Mukherjee*, New Age International Publisher; First edition (2011)
9. *Solar Photovoltaics: Fundamentals, Technologies and Applications*, Chetan Singh Solanki PHI; 3 edition 2015.



**RETM-209**

**LABORATORY -III**

**[COMPUTER LAB]**

**BASICS OF COMPUTER ARCHITECTURE AND NETWORKING**

1. Knowledge of hardware that goes in the making of a computer: Assembling of PC.
2. Installation of OS, setting up of dual boot, installation of hardware and software.
3. Hands on experience on the basic utilities in computers.
4. Execution of File handling commands in DOS Prompt.
5. Learning the methodology of accessing websites and Online resources through the Internet.

**OFFICE AUTOMATION SOFTWARE**

*Note: students can use version of office from office 2007 onwards to office2013.*

1. Prepare a sales invoice using Excel.  
Use the template below and create your own invoice for purchased products. You must include sales tax, discount percentages and at least four items in your invoice. Do all formulas required. Format the invoice is:

Item	Quantity	List Price	Discount	Your Price	Total
Subtotal					

Sales Tax					
Amount Due					

2. Create your bio-data using proper formatting in MS-Word.

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3. Open a new MS Word file and type the following text given in the box below.

Academy award

The Academy Awards, informally known as The Oscars®, are a set of awards given annually for excellence of cinematic achievements. The Oscar statuette is officially named the Academy Award of Merit and is one of nine types of Academy Awards. The Academy Awards ceremony is also the oldest award ceremony in the media; its equivalents, the Grammy Awards (for music), Emmy Awards (for television), and Tony Awards (for theatre) are modeled after the Academy. Current special categories

Academy Honorary Award: since 1929

Academy Scientific and Technical Award: since 1931

Gordon E. Sawyer Award: since 1981

- a) Change the layout of the page as given below.  
>Page size: A4 (8.27" x 11.69") >Page orientation: Landscape
- b) Change the page margins as follows:  
>Top: 1.25" >Bottom: 1.25" >Right: 1.25" >Left: 1.25"
- c) Format the entire document as given below.  
>Line spacing: 1.15" >Font: Times New Roman >Font size: 14 >Align: Justify
- d) Select the heading "Academy award" and format it as given below.  
>Font color: blue >Style: Bold and underline >Align: Center >Change all the letters to UPPERCASE.
- e) Make the first letter of the paragraph larger and fall into three lines (Drop cap).
- f) Format the heading "Current special categories" with Style: Heading 2.
- g) Create a bulleted list for the last 3 lines of text given under "Current special categories" and format it as follows.



4. Use mail merge for the admission form as shown:

PHOTO	
NAME	
DOB	
GENDER	
COURSE	
ADDRESS	
EXAM PASSED	
CATEGORY	

NEXT →

5. Using excel create PPF(public provident fund calculator).

It gives the amount with interest after 15 year onwards. Ask user for input.(monthly inv by 5th of every month, no interest for the month when investment after 5th, rate take as 8.7% . Interest calculated should be added only at the end of the financial year that is April)

6. A Computer company is trying to sell a software that costs 10\$ per copy with a fixed cost of 50\$.

The data from previous sales shows the following:

Selling Price ( $p$ )	10	15	20	25	dollars
Quantity Sold ( $q$ )	40	25	13	5	units

Make formulas for each function:

$$\text{Revenue} = (\text{Selling price})(\text{Quantity})$$

$$\text{Cost} = \$10 \text{ per unit} + \text{fixed Cost}$$

$$\text{Profit} = \text{Revenue} - \text{Cost}$$

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Cost					dollars
Revenue					dollars

Profit					dollars
--------	--	--	--	--	---------

Use the above tables and create a graph showing R, C and P with the Quantity as the X axis for each function. For chart type, use the XY Type. Now, add Trendline and choose the Polynomial type for R and P, and Linear type for C. Make sure you activate Display Equation on Chart which can be found under Option Tab

7. Create a presentation having Proper layout, images , sound, graph, some animation
8. Demonstrate use of VLOOKUP, HLOOKUP, COUNTIF, COUNTIFS, PMT, SUMIF, SUMIFS.
9. To Demonstrate the operation of a diode ROM
10. To show how address decoding reduces the number of input lines required for a ROM. To implement arithmetic functions using diode ROMs.

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**RETM-210****LABORATORY -IV****[RENEWABLE ENERGY LABORATORY]**

1. Evaluate the Tip Speed Ratio "TSR" at different wind speeds.
2. To evaluate the cut-in speed of wind turbine experimentally.
3. Draw the turbine power versus wind speed curve.
4. Evaluate the DC power for a given load at different wind speeds.
5. Evaluate  $U_L$ ,  $F_R$ ,  $\eta$  in thermosyphonic mode of flow with fixed input parameters.
6. Evaluate  $U_L$ ,  $F_R$ ,  $\eta$  in thermosyphonic mode of flow with different wind speeds.
7. Evaluate  $U_L$ ,  $F_R$ ,  $\eta$  in thermosyphonic mode of flow with different intensity.
8. Evaluate  $U_L$ ,  $F_R$ ,  $\eta$  in thermosyphonic mode of flow with different tilt angles.
9. To study the operation of solar based battery charger using solar based single phase power generation module.
10. To study the open loop and close loop control operator of single phase inverter using solar based single phase power generation module.
11. To test the performance of the given thermal storage system containing phase change material (PCM) under charging mode.
12. To test the performance of the given thermal storage system containing phase change material (PCM) under dis charging mode.
13. To calculate the overall efficiency of PCM.
14. Study of PWM charge controllers using single solar panel.
15. Study of PWM charge controllers with series connection of solar panels
16. Study of PWM charge controllers with parallel connection of solar panels
17. To study the MPPT Charge controllers with series connection of solar panels

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**SEMESTER III (ADVANCED DIPLOMA COURSE)**

**RETM - 301**

**INNOVATIONS IN SCIENCE**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. To develop an understanding of the world of science and its relevance to the 21<sup>st</sup> century.
2. To develop critical thinking ability using scientific methods through the study of the milestone innovations of the 20<sup>th</sup> century.
3. To analyze these innovations for their relevance to society.

**UNIT - I**

**[10 LECTURES]**

**Brief History of Modern Science:** Important Innovations in the 18-19 Century and its impact on society; Advances in Basic Sciences: Physics, Chemistry, Biology; Advances in Technology: Industrial Revolution, Wireless communication – Telegraphy, Radio, Computer.

**UNIT - II**

**[12 LECTURES]**

**Important Innovations in the 20<sup>th</sup> Century:** Physical Sciences and Technology, Advances in Astronomy and Cosmology: How do Stars Shine? : Energy production, Life Cycle of Stars, The Large scale structure of Universe: Galaxies and Beyond, The Atomic and Nuclear Physics: Supports and Destroys life, Advances in Technology: Invention of a Transistor, Automobiles, Airplanes, Phones, Personal Computers, Internet etc. 3D printing technology, Inventions that made our lives easy, Advances in Geology: Plate Tectonics, Gemology, Advances in Chemistry and its use in daily life.

**UNIT - III**

**[13 LECTURES]**

**Important Innovations in the 20<sup>th</sup> Century:** Biological Sciences and Technology; General topics from Biochemistry, Biophysics, Molecular Biology: Biodiversity, Medicinal Plants, Understanding Life, The Cell Structure, DNA double helix structure, Genome Project, etc.; Health and Environment: Hormones and Health, Medical Advances: Antibiotics, Organ transplantation.

**UNIT - IV**

**[10 LECTURES]**

Serendipity, Frugal Innovation, India a hub of Frugal Innovation, Innovations in Space in India, Mars Orbital Mission, PSLV mission, Indian telecom system, Characteristics of frugal innovation;

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**Make in India:** The five pillars of make in India; **Digital India:** Vision and Nine pillars of Digital India, Skill India Mission.

**RECOMMENDED REFERENCES:**

1. H. S. Fogler and S.E. LeBlanc, *Strategies for Creative Problem Solving*, Prentice Hall, 1995.
2. E. Sickafus, *Unified Structured Inventive Thinking*, Ntelleck, 1997.
3. Broad Kirsten and Ian Thomson (2012) *Our frugal future and lessons from India's innovation system*, London, NESTA ([http:// www.nesta.org.uk/](http://www.nesta.org.uk/))
4. *Manorama Yearbook 2015 Malayala Manorama Press ,Kottayam*
5. *Mathrubhumin Yearbook Plus 2016*

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RETM - 302

APPLIED MATHEMATICS

TOTAL LECTURES REQUIRED: 45

LEARNING OBJECTIVES

1. Apply mathematical concepts and principles to perform computations.
2. Apply mathematics to solve problems.
3. Create, use and analyze graphical representations of mathematical relationships.
4. Communicate mathematical knowledge and understanding.
5. Apply technology tools to solve problems.

UNIT - I

[12 LECTURES]

**Differential Calculus:** Leibnitz's theorem, Partial derivatives, Euler's theorem for homogeneous functions, Total derivatives, Jacobian, Approximation of errors, Extrema of functions of several variables.

UNIT - II

[12 LECTURES]

**Linear Algebra:** Inverse of a matrix by elementary transformations, Rank of a matrix (Echelon & Normal form), Linear dependence, Consistency of linear system of equations and their solution, Characteristics equation, Eigen values and Eigen vectors, Cayley-Hamilton Theorem.

UNIT - III

[11 LECTURES]

**Laplace Transform:** Introduction, Important Formulae, Properties of Laplace Transforms, shifting formula, Laplace Transform of the Derivative of  $f(t)$ , Laplace Transform of Integral of  $f(t)$ , Laplace Transform of  $t.f(t)$  (Multiplication by  $t$ ), Laplace Transform of  $t, 1/f(t)$  (Division by  $t$ ).

UNIT - IV

[10 LECTURES]

**Vector Calculus:** Point function, Gradient, Divergence and Curl and their physical interpretations, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Applications of Green's, Stoke's and Gauss divergence theorems (without proofs).



**RECOMMENDED REFERENCES:**

1. E. Kreyszig, *Advanced Engineering Mathematics, Volume-I*, John Wiley and Sons.
2. B.V. Ramana, *Higher Engineering Mathematics*, Tata Mc Graw-Hill Publishing Company Ltd.
3. R.K. Jain and S.R.K. Iyenger, *Advance Engineering Mathematics*, Narosa Publishing House.
4. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers.
5. Peter V. O' Neil, *Advanced Engineering Mathematics*, Thomas (Cengage) Learning.
6. Thomas & Finley, *Calculus*, Narosa Publishing House.
7. Rukmangadachari, *Engineering Mathematics - I*, Pearson Education.

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RETM - 303

MECHANICS & THERMODYNAMICS FOR ENERGY APPLICATION

TOTAL LECTURES REQUIRED: 45

LEARNING OBJECTIVES

1. To familiar students to the basics of mechanics & thermodynamics and their fundamentals.
2. To enable & encourage students to apply the subject skill in different applications, as this portion will play a vital role in understanding the concept for structural based analysis & technological information of various system used in energy.

UNIT - I

[12 LECTURES]

**Forces in Structures:** Forces, Moments of forces, Types of forces and moments, Stress-Strain Diagrams, Fracture at Low Stresses, Tensile stress, Compressive stress, Fatigue, Creep, Hardness of materials, bending of beams, basic of civil work & foundation.

UNIT - II

[12 LECTURES]

**Fluid Mechanics:** Types of Fluid, fluid statics, Bernoulli's equation, Conservation of mass, Definition of viscosity, Reynolds number, Navier-Stokes equations, Laminar and turbulent flow.

UNIT - III

[11 LECTURES]

**Thermodynamic System:** Introduction, Properties, process, cycle, thermodynamic equilibrium, Quasi-static Process, Zeroth Law of thermodynamics, Work and Heat transfer, flow work.

**First Law of Thermodynamics:** Internal energy, proof of internal energy as a point function.

UNIT - IV

[10 LECTURES]

**Second Law of Thermodynamics:** Limitations of the First Law – Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance, Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence.

**Thermodynamic Relationships:** T-dS equations, difference in heat capacities, coefficient of Volume expansion and isothermal compressibility, adiabatic compressibility, ratio of specific heat.

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**RECOMMENDED REFERENCES:**

1. N.D. Bhatt, *Elementary Engineering Drawing*, Chartor Publishing house, Anand, India.
2. D. N. Johle, *Engineering Drawing*, Tata McGraw-hill Publishing Co. Ltd.
3. P. K Nag "Thermodynamics", Tata McGraw-Hill Publishing Co. Ltd
4. *Building Construction --- Bindra Arora; Dhanpat Rai publication.*
5. Dr. R.K. Bansal, *Fluid Mechanics*, Laxmi Publication (P) Ltd. New Delhi
6. *Engineering Mechanics (Statics and Dynamics); A. K. Tayal ,Umesh Pub., Delhi*
7. *Engineering Thermodynamics: C.P.Arora, TMH*

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RETM - 304

ELECTRICAL SYSTEMS

TOTAL LECTURES REQUIRED: 45

LEARNING OBJECTIVES

1. To familiar students to the basic concepts of electrical & its laws.
2. To get student squinted with principles of electrical devices.
3. Concepts of electrical system will play major role in designing the power plants & their operation.

UNIT - I

[12 LECTURES]

**Single Phase A.C. Circuits:** Production of ac voltage, waveforms and basic definitions, root mean square and average values of alternating currents and voltage, form factor and peak factor, phasor representation of alternating quantities, the j operator and phasor algebra, analysis of ac circuits.

UNIT - II

[12 LECTURES]

**Three Phase AC circuits:** Introduction, Generation of Three-phase EMF, Phase sequence, Connection of Three-phase Windings - Delta and Star connection: Line and Phase quantities, phasor diagrams, Power equations in balanced conditions.

UNIT - III

[11 LECTURES]

**Magnetic Circuits:** Introduction, Magnetomotive force (MMF), Magnetic field strength, Reluctance, B-H curve, Comparison of the Electric and Magnetic Circuits, Series-Parallel Magnetic Circuit, Leakage flux and fringing, Magnetic Hysteresis, Eddy currents.

UNIT - IV

[10 LECTURES]

**Single Phase Transformers:** Introduction, Principles of operation, Constructional details, Ideal Transformer and Practical Transformer, EMF equation, Rating, Phasor diagram on no load, Losses, Efficiency calculations.

**Direct Current Machines:** Constructional details, Principle of operation of DC machines, e.m.f. equation, Torque production, classification of DC machines, Starting of DC motors.

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**RECOMMENDED REFERENCES:**

1. V.N. Mittle and Arvind Mittal, "Basic Electrical Engineering", Second Edition, Tata McGraw Hill.
2. Del Torro, Vincent "Electrical Engineering Fundamentals", Second Edition Prentice Hall of India Pvt. Ltd.
3. Fitzrald and Higgonbothom, "Basic Electrical Engineering", Fifth Edition, McGraw Hill.
4. D.P. Kothari and I.J. Nagrath, "Theory and Problems of Basic Electrical Engineering", PHI.
5. I.J. Nagrath and D.P. Kothari, "Electrical Machines", Tata-McGraw Hill.
6. Ashfaq Hussain, "Fundamentals of Electrical Engineering", Third Edition, Dhanpat Rai and Co.
7. H. Cotton, "Advance Electrical Technology," ISSAC Pitman, London.
8. Parker Smith S. (Ed. Parker Smith N.N.), "Problems in Electrical Engineering", Tenth edition, Asia publication.

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**RETM - 305**

**SOLAR PV POWER PLANT & COMPONENTS**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

This subject will enable students to understand the Designing, Installation and Operation & Maintenance of Solar Based Power Plants

**UNIT - I**

**[12 LECTURES]**

calibration of SCADA/any monitoring system, prepare inspection report and forward to site-in charge for further, on getting the clearance from electricity inspector, initiate start-up procedures as per manufacturer's instructions, monitor the energy readings and voltages at regular intervals on start up, record and report any anomalous condition to the site in-charge for further action.

**UNIT - II**

**[12 LECTURES]**

Prepare as-built drawings and document design changes including signages and warnings at appropriate places, if any, operation and maintenance of solar power plant to ensure periodical cleaning of solar module array, periodically ensure tightness of cable connections to ensure periodic maintenance of the solar plant.

**UNIT - III**

**[11 LECTURES]**

Check modules earmarked for powerplant using a random selection as per relevant IS/IEC standards, visit manufacturing facility of inverter supplier and witness testing of a few inverters, collect documentation related to each and every equipment and submit to site in-charge, on receipt of material at site, ensure proper delivery/off-load of solar equipment, check all the material and equipment received at site for any physical damage, ensure specifications of the equipment and components match with what has been ordered, ensure all warranties by manufacturers are properly signed and are in order.

**UNIT - IV**

**[10 LECTURES]**

Installation, inspect the foundations of structures, inspect the inter-row spacing and alignment, inspect and verify cable routes and specifications as per design documents, inspect module

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installation, inspect the cable terminations and ensure tightness, inspect the installation of inverters, protection devices and systems, after installation carry out visual inspection of the plant to find out defects and deficiencies, measure and record the circuit voltage and short circuit current of all the module strings and compare that with design values, carry out thermography of doubtful strings and modules to know the defects carry out performance ratio test by continuous operation of the plant as per the industry norms and compare with designed values, preparing handing over documents, collect and compile conformity, warranty documentation, performance guarantees, calibration certificates and any other relevant documentation and handover to site in-charge, certificates, Prepare final as-is drawings, Prepare O&M schedule to be handed over to the agency and ensuring asset and personal security systems are in place for their effectiveness.

**RECOMMENDED REFERENCES:**

1. *Renewable Energy Sources and Emerging Technologies*, Kothari D.P. and Singal K. C, New Arrivals - PHI; 2 edition (2011)
2. *Solar Energy, Fundamentals, Design, Modelling & Applications*, G.N.Tiwari, Narosa Publishing House.
3. *Solar Engineering of Thermal Processes*, John A. Duffie, William A. Beckman, John Wiley & sons.
4. *Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers*, Chetan Singh Solanki, PHI (1 January 2013)
5. *Fundamentals of Renewable Energy Systems Paperback* – D. Mukherjee, New Age International Publisher; First edition (2011)
6. *Solar Photovoltaics: Fundamentals, Technologies and Applications*, Chetan Singh Solanki PHI; 3 edition 2015.



**RETM - 306**  
**PROGRAMMING C++/JAVA**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. Understand object-oriented programming features in C++.
2. Apply these features to program design and implementation.
3. Make them learn about Java programming concepts, graphical user interfaces, basic data structures.

**UNIT - I**

**[12 LECTURES]**

**Object-Oriented Programming Concepts:** Introduction, comparison between procedural programming paradigm and object-oriented programming paradigm, basic concepts of object-oriented programming - concepts of an object and a class, interface and implementation of a class, operations on objects, relationship among objects, abstraction, encapsulation, data hiding, inheritance, overloading, polymorphism, messaging.

**UNIT - II**

**[12 LECTURES]**

**Standard Input/Output:** Concept of streams, hierarchy of console stream classes, input/output using overloaded operators >> and << and member functions of i/o stream classes, formatting output, formatting using ios class functions and flags, formatting using manipulators. Classes and Objects: Specifying a class, creating class objects, accessing class members, access specifiers, static members.

**UNIT - III**

**[11 LECTURES]**

**Introduction to Java and Java Programming Environment:** Fundamental Programming Structure: Data Types, variable, Typecasting Arrays, Operators and their precedence. Control Flow: Java's Selection statements (if, switch, iteration, statement, while, do-while, for, Nested loop) Concept of Objects and Classes, Using Existing Classes building your own classes, constructor overloading, static, final, this keyword.

**UNIT - IV**

**[10 LECTURES]**

**Inheritance:** Using Super to Call Super class constructor, Method overriding, dynamic method Dispatch, Using Abstract Classes, Using final with inheritance, the Object Class, Packages & Interfaces: Packages, Access Protection, Importing package, Interface, Implementing Interfaces, variables in Interfaces, Interfaces can be extended, Exception Handling: Fundamentals, Types



Checked , Unchecked exceptions, Using try & catch, Multiple catch, throw , throws, finally, Java's Built in exceptions, user defined exception.

**RECOMMENDED REFERENCES:**

1. *Introduction to Java Programming: Liang, Pearson Education, 7th Edition.*
2. *Java The complete reference: Herbert Schildt, TMH, 5th Edition.*
3. *Balguruswamy, Programming with JAVA, TMH.*
4. *Programming with Java: Bhave & Patekar, Pearson Education.*
5. *Lafore R., Object Oriented Programming in C++, Waite Group.*
6. *E. Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill.*
7. *R. S. Salaria, Mastering Object-Oriented Programming with C++, Salaria Publishing House.*
8. *BjarneStroustrup, The C++ Programming Language, Addison Wesley.*
9. *Herbert Schildt, The Complete Reference to C++ Language, McGraw Hill-Osborne.*
10. *Lippman F. B, C++ Primer, Addison Wesley.*

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**RETM - 307**

**SOLAR WATER PUMPING SYSTEM**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. To understand solar pumping systems.
2. The principle of photovoltaic technologies and their characteristics used in water pumping.
3. Estimation of cost, installation and commissioning of pumping systems.

**UNIT - I**

**[12 LECTURES]**

Design of solar water pumping system, analyze the water usage and level of water table at site – consider seasonal variation in water level & quality of water and propose appropriate pump model, decide on the specifications of the pumping set and motor (DC/AC or surface/submersible).

**UNIT - II**

**[12 LECTURES]**

Decide on the capacity of PV modules, design of mounting structures and foundation, installation, test and commissioning of solar pumping system, oversee the preparation of the foundation for solar module mounting structure and motor pump set, ensure structure is fixed on the foundations or fixed securely on mobile unit, where applicable,

**UNIT - III**

**[11 LECTURES]**

Oversee the mounting of solar modules, oversee the connection of solar module array to pump set in case of DC pumps, oversee the installation of inverter in case of AC pumps or VFD, if applicable. Ensure protection systems are in place or perform inspection and testing of equipment, perform start-up procedures and measure output, compare the output with design output and take corrective actions.

**UNIT - IV**

**[10 LECTURES]**

Connection of the solar module array to motor pump set through a Maximum Power Point Tracker (MPPT) to get maximum power from the array, install an inverter after MPPT to convert

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DC power to AC power in case an AC submersible motor pump set is used. operation and maintenance of solar pumping system, ensure periodical cleaning of solar module array, periodically ensure tightness of cable connections , ensure periodic maintenance of motor pump set.

**RECOMMENDED REFERENCES:**

1. *Renewable Energy Sources and Emerging Technologies*, Kothari D.P. and Singal K. C, New Arrivals - PHI; 2 edition (2011)
2. *Solar Energy, Fundamentals, Design, Modelling & Applications*, G.N.Tiwari, Narosa Publishing House.
3. *Solar Engineering of Thermal Processes*, John A. Duffie, William A. Beckman, John Wiley & sons.
4. *Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers*, Chetan Singh Solanki, PHI (1 January 2013)
5. *Fundamentals of Renewable Energy Systems Paperback* - D. Mukherjee, New Age International Publisher; First edition (2011)
6. *Solar Photovoltaics: Fundamentals, Technologies and Applications*, Chetan Singh Solanki PHI; 3 edition 2015.

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**RETM - 308**

**EVALUATION AND MONITORING FOR WIND POWER PLANT**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. Awareness about various Wind Energy.
2. Understanding the design considerations of Wind projects.
3. Awareness about global scenario & current status.
4. Get acquainted to various types of Wind power stations.

**UNIT - I**

**[12 LECTURES]**

Conduct preliminary analysis for the project, identify project objectives and constraints, study the prefeasibility and feasibility study and identify physical viability of project execution, analyse the project DPR in detail and assist in preparing a work plan, analyse the wind farm layout and identify necessary permits and clearances to be taken, identify the possible risks associated with the project and assist in preparing risk mitigation procedures, analyse the environmental impact studies and plan for necessary clearances, prepare a report of preliminary analysis of the project and submit to the planning engineer, assist in preparing the project plan for wind power plant.

**UNIT - II**

**[12 LECTURES]**

Identify and prepare a plan for taking necessary clearances as per general local framework like municipal permits, grid permit, etc. carry out route survey for material delivery at site, assist in planning for procurement and manufacturing of wind power plant components, assist in material planning and handling assist in manpower and resource planning for project execution, prepare a time schedule for each of the activities, identify the location for project site office and ensure its construction as per specification, plan for construction power supply at project site, plan for safety and security of man and material at project site.

**UNIT - III**

**[11 LECTURES]**

Establish suitable Project Management technics and prepare all necessary formats, organize tasks concurrently to make optimal use of workforce during project execution, assist in undertaking personnel selection and evaluation for project execution, monitor and report the progress of the construction of access roads for material delivery at site, monitor and report the progress of equipment and material delivery at wind project site.



**UNIT - IV**

**[10 LECTURES]**

Prepare consolidated relevant report and presentations for project monitoring, ensure following of industry standards within the wind site, ensure following contingency plan in case of unforeseen delay. Carry out regular site visits to ensure protocols are followed, ensure restoration of site post commissioning, prepare handover documentation as per prescribed format.

**RECOMMENDED REFERENCES:**

1. *Freris L.L: Wind Energy Conversion Systems, Prentice Hall*
2. *Brendan Fox: Wind power integration : connection and system operational aspect*
3. *Frede Blaabjerg, Zhe Chen: Power electronics for modern wind turbines*
4. *Olimpo Anaya-Lara: Wind energy generation : modelling and control*

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**RETM-309**

**LABORATORY -V**

**[DIGITAL ELECTRONICS]**

1. To construct R-S flip flop & study its characteristics without clock.
2. To construct R-S flip flop & study its characteristics with clock.
3. To study & verify the truth table of basic logic gates.
4. To study & verify the truth table of universal logic gates.
5. To study, design & verify the truth table of arithmetic gates.
6. To study the Boolean algebraic theorems and verification of single variable theorem.
7. To study the Boolean algebraic theorems and verification of more than one variable theorem.
8. To study the Boolean algebraic theorems and verification of Demorgan's theorem.
9. To verify the operation of 16 line to 1 line digital multiplexer.
10. To demonstrate how multiplexer can be used to convert a parallel data input to a serial data output device.
11. To verify the operation of 1 line to 16 line demultiplexer.
12. To demonstrate the operation of 4 line to 16 line decoder.
13. To demonstrate how 4 line to 16 line decoder can be used to sequence among any number of states, between one and fifteen.
14. To study the operation of 4 bit binary full adder and subtractor for addition of two 4 bit binary numbers.
15. To study the operation of 4 bit binary full adder and subtractor for subtraction of two 4 bit binary numbers.
16. To construct D flip flop & study its characteristics.
17. To construct T flip flop & study its characteristics.
18. To construct master JK flip flop & study its characteristics.
19. To construct JK flip flop & study its characteristics.



**RETM-310**

**LABORATORY -VI**

**[RENEWABLE ENERGY LABORATORY]**

1. To evaluate the Tip Speed ratio (TSR) at different wind speeds
2. To evaluate the coefficient of performance of wind turbine.
3. Draw the turbine Power versus wind speed curve.
4. Draw the curve between TSR and coefficient of power.
5. Demonstrate the power analysis at turbine output (for high wind speeds).
6. Demonstrate the power analysis at different branches of wind turbine energy system (at high frequency) with AC load only.
7. Demonstrate the power analysis at different branches of wind turbine energy system (at high frequency) with DC load only.
8. Draw the power curve of turbine with respect to the rotational speed of rotor at fixed wind speed.
9. Evaluation of different parameters ( $U_L$ ,  $F_R$  and  $\eta$ ) in thermosyphonic mode of flow at different radiation level.
10. Evaluation of different parameters ( $U_L$ ,  $F_R$  and  $\eta$ ) in thermosyphonic mode of flow with different wind speed.
11. Evaluation of different parameters ( $U_L$ ,  $F_R$  and  $\eta$ ) in forced mode of flow with fixed input parameters.
12. To study the PV losses of 10 W, 20 W and 100 W solar cells at different loads with fixed intensity of light.
13. To study the PV losses of 10 W, 20 W and 100 W solar cells at different loads with different intensity of light.
14. To test the performance of the given thermal storage system containing fatty acid under charging mode.
15. To test the performance of the given thermal storage system containing fatty acid under discharging mode.
16. To evaluate the efficiency of the given thermal storage system containing fatty acid.
17. To analyze the setup for DC-DC & DC-AC Converter with Standalone PV system.
18. Study of I-V Tracer for I-V characteristics measurements.

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**SEMESTER IV**

**RETM - 401**

**ENERGY MANAGEMENT, AUDITING & UTILIZATION**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. Better energy conservation
2. Cost reduction & efficiency
3. Energy auditing & plugging of losses
4. Awareness about Energy Management Principles & energy audit procedure as adopted by the Bureau of Energy Efficiency, Ministry of Power, GoI.

**UNIT - I**

**[12 LECTURES]**

**ENERGY CONSERVATION:** Energy Conservation and its Importance; Energy Strategy for the Future; the Energy Conservation Act, 2001 and its Features

**ENERGY MANAGEMENT:** Definition & Objectives of Energy Management; Importance; Indian need of Energy Management; Duties and responsibilities of energy managers.

**UNIT - II**

**[11 LECTURES]**

**ENERGY AUDIT:** Energy Audit: Types and Methodology; Energy Audit Reporting Format; Understanding Energy Costs; Benchmarking and Energy Performance; Matching Energy Usage to Requirement; Maximizing System Efficiency; Energy Audit Instruments; Duties and responsibilities of energy auditors.

**UNIT - III**

**[11 LECTURES]**

**MATERIAL AND ENERGY BALANCE:** Basic Principles; The Sankey Diagram and its Use; Material Balances; Energy Balances; Method for Preparing Process Flow Chart; Facility as an Energy System; How to Carryout Material and Energy (M & E) Balance.

**UNIT - IV**

**[11 LECTURES]**

**ENERGY POLICY PLANNING AND IMPLEMENTATION KEY ELEMENTS:** Force Field Analysis, Energy Policy-Purpose, Perspective, Contents and Formulation. Format and Ratification, Organizing; Location of Energy Manager, Top Management Support, Managerial functions, Role and responsibilities of Energy Manager, Accountability, Motivation of employees.

*G. Thakur*  
18-1-2020

*H. S. Tripathi*

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**RECOMMENDED REFERENCES:**

1. LC Witte, PS Schmidt, DR Brown, *Industrial Energy Management and Utilization*, Hemisphere Publication, Washington, 1988.
2. *Industrial Energy Conservation Manuals*, MIT Press, Mass, 1982.
3. IGC Dryden, Butterworths (Ed), *The Efficient Use of Energy*, London, 1982.
4. WC Turner (Ed), *Energy Management Handbook*, Wiley, New York, 1982.
5. *Technology Menu for Efficient energy use- Motor drive systems*, Prepared by National Productivity Council and Center for Environmental Studies, Princeton University, 1993.
6. Frank, Kreith, Ronald E West *Hand Book of Energy Efficiency*, CRC Press.
7. Bureau of Energy Efficiency Study Material for Energy Managers and Auditors Examination Paper I to IV.
8. BG Desai, BS Vaidya DP Patel and R Parman, *Savings Electricity in Utility Systems of Industrial Plants Efficient use of electricity in industries*.
9. *Instructions to Energy Auditors, Vol - I and Vol - II National Technical Information Services US Deptt of Commerce Springfield, VA 22161.*
10. *Energy Auditing, The Fairmont Press Inc Published by Atlanta, Georgia.*

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18-1-2020

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**RETM - 402**

**POWER ELECTRONICS**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. To understand and acquire knowledge about various power semiconductor devices.
2. To prepare the students to analyze and design different power converter circuits.
3. Analyze basic operation of switching power converters.
4. Simulate detailed, average, and small-signal operation of power converters.

**UNIT - I**

**[14 LECTURES]**

**Thyristor:** Silicon controlled rectifier (SCR), construction and principle of operation, two-transistor analogy, static and dynamic characteristics, gate characteristics, ratings, different methods of turning on, turning off and triggering of SCRs, Series and parallel operation of SCRs, load commutation, forced commutation and external pulse commutation, string efficiency.

**UNIT - II**

**[14 LECTURES]**

**Phase Controlled Rectifiers:** Principle of phase control, performance parameters, single-phase half wave and full wave controlled rectifiers, mid-point and bridge converters, full controlled converters, half controlled converters, comparison between full and half controlled converters.

**UNIT - III**

**[08 LECTURES]**

**DC to DC Converters:** Principle and Control Techniques of Choppers, analysis of step-down chopper with RLE load, Classification of choppers, commutation methods for choppers.

**UNIT - IV**

**[09 LECTURES]**

**Inverters:** Classification of Inverters, Series Inverter, Parallel Inverter, Bridge Inverter, Cyclo-converters: Basic Principle of operation, step-up and step-down single phase to single phase cyclo-converters.

**RECOMMENDED REFERENCES:**

1. "Power electronics", Rashid, PHI pbs
2. "An introduction to thyristor and its applications", Ramamurthy, EWP.
3. "A text book of power electronics", S.N Singh, Dhanpat Rai.
4. Power electronics, Murthy, Oxford.
5. "Power electronics", P. C. Sen, TMH.

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**RETM - 403**

**CONTROL & EMBEDDED SYSTEMS**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. The basic concepts of process control and controllers.
2. Electronic realization of controllers.
3. Embedded system and automation.
4. Advanced controls in solar plants.

**UNIT - I**

**[12 LECTURES]**

Introduction, Decimal Number System, Binary Number System, conversion, Binary - Decimal, Decimal - Binary, Addition of Binary Numbers, Binary Subtraction, DeMorgan's theorem, universal gates, Introduction to Multiplexer & Demultiplexer, Encoder & decoder, code converters, Flip Flops.

**UNIT - II**

**[11 LECTURES]**

**Microprocessor Architecture:** Introduction to Microprocessors, Difference between Microprocessor & Microcontroller, Classification based on architecture, Memory Classification, Description of RAM, Description of CPU Registers, Functions of SFR.

**UNIT - III**

**[11 LECTURES]**

Introduction to embedded system, embedded system architecture, classifications of embedded systems, challenges and design issues in embedded systems, fundamentals of embedded processor and microcontrollers, CISC vs. RISC, fundamentals of Vonneuman/Harvard architectures, types of microcontrollers, selection of microcontrollers.

**UNIT - IV**

**[11 LECTURES]**

Elements of control systems, concept of open loop and closed loop systems, Examples and application of open loop and closed loop systems, brief idea of multivariable control systems.

**RECOMMENDED REFERENCES:**

1. *Linear Control Systems with MATLAB Applications*, B S Manke, Khanna Publishers.
2. *Control Systems Engineering-* by I.J. Nagrath and M. Gopal, New Age International (P) Limited, Publishers.

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3. *Automatic Control Systems, B.C.Kuo, John wiley and son's.*
4. *The 8051 Microcontroller and Embedded Systems using Assembly and C, Mazidi, Mazidi & McKinlay, PHI.*

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*H. D. Singh*



**RETM - 404**

**MATERIAL SCIENCE FOR ENERGY APPLICATIONS**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. Basics of materials science and engineering.
2. Properties of various materials and special coatings and applications.
3. Testing of materials behavior suitable for application in solar energy systems.
4. Environmental impact on solar system materials and corrosion protection.

**UNIT - I**

**[12 LECTURES]**

**FUNDAMENTAL PRINCIPLES OF MATERIALS SCIENCE:** Electronic and atomic structures, atomic bonding in solids, crystal structure, microstructure, solidification, alloys, semiconductors, ceramics, polymers.

**UNIT - II**

**[11 LECTURES]**

**PROPERTIES OF MATERIALS:** Super conductivity and applications. Mechanical, optical, thermal electrical and magnetic properties of metals, alloys, semiconductors, polymers, glass, nanomaterials and magnetic materials.

**UNIT - III**

**[11 LECTURES]**

**TESTING OF MATERIALS:** Concepts of stress and strain, Hooke's law, tension, compression and shear. Stress-strain diagram and thermal stresses, Elasticity in metals and polymers, plastic deformation, yield stress, shear strength, strengthening mechanisms.

**UNIT - IV**

**[11 LECTURES]**

**EFFECTS ON MATERIALS:** Environmental effects - corrosion, erosion, thermal stress and weathering properties of solar materials, Effect of temperature, fracture behavior of various materials, failure analysis of solar materials.

**RECOMMENDED REFERENCES:**

1. Ramamrutam S., "Strength of Materials", 16<sup>th</sup> edition, Danpat Rai Publications, 2010
2. Callister W.D., Materials Science and Engineering 6<sup>th</sup> edition, Wiley India, 2009
3. Sheckel ford J., F. Muralidham M.K., "Introduction to Materials Science for Engineers", 6<sup>th</sup> edition, Pearson, 2007.
4. RaghavanV., "Materials Science and Engineering", Prentice-Hall India, 2007.

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5. Askeland D.R., "Science and Engineering of Materials", 4<sup>th</sup> edition, Thomson, 2003.
6. Bala subramaniam R., "Callister's Materials Science and Engineering", Wiley India, 2007.
7. Ben G. Streetman, Solid State electronic devices, Prentice-Hall of India Pvt. Ltd., New Delhi, 1995.

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**RETM - 405**

**SOLAR THERMAL TECHNOLOGIES**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. The fundamentals of design calculations and analysis of solar thermal systems.
2. The functioning and design of solar thermal cooling systems.
3. The basics of solar thermal technology for process heating applications.
4. The fundamentals of design calculations and economics of solar power generation.

**UNIT - I**

**[14 LECTURES]**

Analyze the client requirements, visit the client site to understand the details of their manufacturing process, identify the heat requirement for various process, temperature and quantity, collect data on the present source of heat and its utilization.

**UNIT - II**

**[14 LECTURES]**

Compute the shadow free open area available on the ground or rooftop for installation of solar thermal system, analyze solar radiation data for the project site, describe the benefits of using solar thermal technologies to the client.

**UNIT - III**

**[08 LECTURES]**

Solar thermal technology (IES) for supply of process heat, analyze and recommend the relevant solar thermal technologies (i.e. air collectors, FPC/ETC water heater, scheffler disc, parabolic trough collector and linear fresnel reflector collector) as per client requirements and suitability, suggest capacity of solar thermal system with estimated heat output at designed temperature and solar radiation levels.

**UNIT - IV**

**[09 LECTURES]**

design relevant solar thermal technology solution catering to the client's requirement, Identify necessary changes to existing process for integration of solar thermal system, integrate the solar thermal system with the existing process heat supply system, Quality of water and need for treatment plant and thermal storage, if required

**RECOMMENDED REFERENCES:**

1. *Renewable Energy Sources and Emerging Technologies*, Kothari D.P. and Singal K. C, New Arrivals - PHI; 2 edition (2011)

2. *Solar Energy, Fundamentals, Design, Modelling & Applications*, G.N.Tiwari, Narosa Publishing House.
3. *Solar Engineering of Thermal Processes*, John A. Duffie, William A. Beckman, John Wiley & sons.
4. *Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers*, Chetan Singh Solanki, PHI (1 January 2013)
5. *Fundamentals of Renewable Energy Systems Paperback* – D. Mukherjee, New Age International Publisher; First edition (2011)
6. *Solar Photovoltaics: Fundamentals, Technologies and Applications*, Chetan Singh Solanki PHI; 3 edition 2015.



**RETM - 406**

**CONCENTRATING SOLAR THERMAL SYSTEMS**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. To gain knowledge on solar passive heating and cooling.
2. The fundamentals of design calculations and analysis of solar thermal systems.
3. The functioning and design of solar thermal cooling systems.
4. The basics of solar thermal technology for process heating applications.
5. The fundamentals of design calculations and economics of solar power generation.

**UNIT - I**

**[12 LECTURES]**

Site Preparation ,analyze designs and drawings of solar thermal system, ensure proper marking of site as per design and drawings Installation as per design drawings, ensure installation of concentrating collectors and receiver mounting structures, ensure installation and orientation of reflectors/ collector,

**UNIT - II**

**[11 LECTURES]**

Installation of tracking system, ensure installation of piping network including pumping system, ensure installation of temperature sensors, vent and pressure release valves as per the design, ensure the proper integration with auxiliary heating systems

**UNIT - III**

**[11 LECTURES]**

Testing and Commissioning, ensure testing of pressure sensors, temperature sensors and vents/ pressure valves and replace accordingly if any defects found, measure and compare pressure in different tubes as per design values.

**UNIT - IV**

**[11 LECTURES]**

Carry out testing of the piping network for any leakages and rectify accordingly if any defects found, ensure proper working of tracking system, commission the solar thermal system, prepare as- built drawing and document design changes, if any

**RECOMMENDED REFERENCES:**

1. *Renewable Energy Sources and Emerging Technologies*, Kothari D.P. and Singal K. C, New Arrivals - PHI; 2 edition (2011)
2. *Solar Energy, Fundamentals, Design, Modelling & Applications*, G.N.Tiwari, Narosa Publishing House.
3. *Solar Engineering of Thermal Processes*, John A. Duffie, William A. Beckman, John Wiley & sons.
4. *Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers*, Chetan Singh Solanki, PHI (1 January 2013)
5. *Fundamentals of Renewable Energy Systems Paperback* – D. Mukherjee, New Age International Publisher; First edition (2011)
6. *Solar Photovoltaics: Fundamentals, Technologies and Applications*, Chetan Singh Solanki PHI; 3 edition 2015.



RETM - 407

ENGINEERING DRAWING

TOTAL LECTURES REQUIRED: 45

LEARNING OBJECTIVES

1. Use of common drafting tools to construct engineering drawings
2. Apply dimensions on engineering drawings
3. Construct, read and understand the Title and Revision Block
4. Justify the need for sectional views
5. Create 2D drawings, construct and Interpret views and sectional views
6. Build orthographic projections using three view drawings
7. Utilize various line types to give best descriptive drawings
8. Relate dimensions from one view to another

UNIT - I

[12 LECTURES]

**PLANNING AND LAYOUT OF DRAWING:** Planning and layout of drawing, Planning of drawing sheet as per Indian standard, Standard sizes of drawing sheet A0 to A5, Marginal space & Title block, Folding of drawing sheet; Standard scale, Enlarging scale, Reducing scale, Practice of drawing enlarging and reducing scale (Engineering scale).

**PRACTICE PROBLEMS OF SIMPLE GEOMETRICAL CONSTRUCTION:** Construction of circle, Bi-section of line, Bi-section of an angle, Construction of a regular polygon, Connecting circles and straight lines.

UNIT - II

[11 LECTURES]

**PROJECTION OF POINTS AND LINES:** Definition of projection, projection of points & lines, classification of projection, projection of points in different planes, projection of lines in different plane, lines inclined to one reference plane.

**PROJECTION OF PLANES AND SOLIDS:** Projection of planes of following shapes: circular, rectangular, pentagonal, hexagonal, projections for above planes for inclined to one plane -for a cube, prism, pyramid.

UNIT - III

[11 LECTURES]

**ORTHOGRAPHIC PROJECTION:** Object, Projectors, Plane of projection (views. -Direction of Vision - Horizontal plane (H.P.) - Vertical plane (V.P.), angle projection method, symbolic representation of first angle projection, method of drawing three views, third angle projection

method, designation of views Front view (Front elevation) -Top view (Plan), side view, method of drawing three views, difference between first angle & third angle methods of projection.

#### UNIT - IV

[11 LECTURES]

**ISOMETRIC PROJECTION:** Meaning of isometric projection, Principles of Isometric Projection Isometric Projection of objects having non- isometric lines, Isometric Projection of parts with Spherical surface, Construction of an isometric scale and rules of dimensioning an isometric view.

#### RECOMMENDED REFERENCES:

1. *Engineering Drawing Shri Gujral and Shende, Khanna Publications, New Delhi*
2. *Elementary Engineering Drawing, Shri. N. D. Bhatt, Charoter Publisher, Anand*
3. *Engineering Graphics. P I Varghese Tata McGraw Hill Education Pvt. Ltd.*
4. *Engineering Drawing P.J. Shah .S.Chand Publishers.*
5. *Engineering Drawing Johle/Tata Macgraw Hill Book Publishers.*
6. *Engineering Drawing M.B. Shah and B.C. Rana, Pearson.*
7. *Engineering Drawing by K.Venu Gopal& V.Prabu Raja New Age Publications.*
8. *Engineering Drawing by John. PHI Learning Publisher.*
9. *Engineering Drawing, R. B. Gupta, Satya Prakashan, Delhi.*



**RETM - 408**

**SOLAR THERMAL SYSTEM**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. Understand the fundamentals of solar flat plate collectors.
2. Analyze the performance of solar flat plate collectors.
3. Understand the fundamentals of concentrating solar collectors.
4. Analyze the performance of concentrating solar collectors.
5. Familiar with the solar low, medium and high temperature applications.

**UNIT - I**

**[10 LECTURES]**

Maintenance of reflectors / collectors , ensure proper cleaning of reflectors/ collectors , check the reflectors/collectors for any defects and report to superiors Maintenance of receivers and circulation system- check the receivers for damage and report to the superiors, check the receivers for black coating/ selective coating and in case of fading of paint, paint it with the black paint provided by the manufacturers for Scheffler and replace with new receiver tube in case of PT and FLR, check the receiver pipes , receivers and heat delivery pipes for scale formation periodically and carry out de-scaling of pipes with descaling chemicals using descalar system, clean and rinse the circulation pump as per relevant industry practices, check for screwed connections of piping and containers and tighten if required ,check for leaks from circulation pipes and repair or replace the leak as well as the insulation on the pipe , replace the resin and filters in the RO system periodically , calibrate the temperature, pressure sensors and flow meters and other gauges, etc. as per design standards on a periodic basis

**UNIT - II**

**[13 LECTURES]**

Maintenance of tracking system, check the sensors, tighten the connecting wires and replace the sensors, in case are found non-functional, lubricate all moving parts of the tracking drive system periodically , check the electrical connections of the drive motor. Work effectively with others- accurately pass on information to the authorized persons who require it and within agreed timescale and confirm its receipt, assist others in performing tasks in a positive manner where required and possible, consult and assist others to maximize effectiveness and efficiency in carrying out tasks, display appropriate communication etiquette while working, display active listening skills while interacting with others at work.



**UNIT - III**

**[12 LECTURES]**

Demonstrate responsible and disciplined behaviors at the work place escalate grievances and problems to appropriate authority as per procedure to resolve them and avoid conflict, identify the need for common grounds with clients, team members, etc. and negotiate in an effective manner to achieve the same, consider and respect the opinions, creativity, values, beliefs and perspectives of others.

**UNIT - IV**

**[10 LECTURES]**

Collaboration and group participation to achieve common goals, promote a friendly, co-operative environment that is conducive to employee's sense of belonging, facilitate an understanding and appreciation of the differences among team members.

**RECOMMENDED REFERENCES:**

1. *Solar Engineering of Thermal Processes*, John A. Duffie, William A. Beckman, John Wiley & sons.
2. *Renewable Energy Sources and Emerging Technologies*, Kothari D.P. and Singal K.C., New Arrivals - PHI; 2 edition (2011)
3. *Solar Energy, Fundamentals, Design, Modelling & Applications*, G.N.Tiwari, Narosa Publishing House.
4. *Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers*, Chetan Singh Solanki, PHI (1 January 2013)
5. *Fundamentals of Renewable Energy Systems*- D. Mukherjee, New Age International Publisher; First edition (2011)
6. *Solar Photovoltaics: Fundamentals, Technologies and Applications*, Chetan Singh Solanki PHI; 3 edition 2015.
7. *From Sunlight to Electricity: A Practical Handbook on Solar Photovoltaic Applications*, Suneel Deambi, The Energy and Resources Institute, TERI (30 January 2009).

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**RETM - 409**

**WORKSHOP PRACTICES - I/MINOR PROJECT**

**COURSE DESCRIPTION**

Overview of state-of-the-art solar technology, development and research in the project area.

Pre-design of innovative solar thermal, PV and hybrid systems and their components with realistic constraints.

Analysis of system performance, economics, and assessment of environmental impact.

Interim report presentation.

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**SEMESTER V (DEGREE COURSE)**

**RETM - 501**

**SOLAR BUSINESS SOLUTIONS**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. Understand the research preparation and planning.
2. Understand various data collection methods.
3. Study various sampling methods.

**UNIT- I**

**[12 LECTURES]**

For smart grids and micro grids, biomass power generation systems business, small scale wind power plant business, solar water pumping systems business, rooftop solar PV business- Assess the market and evaluate the market trends to decide the strategy for sale of solar lighting solutions, identify market opportunities and potential customers, Devise strategy to reach potential customer through business promotion techniques, media outreach plan.

**UNIT- II**

**[10 LECTURES]**

Content for brochures and product catalogues, etc. , identify the customer requirements , clarify the customer queries with respect to solar lighting solutions , assess the area of installation, power output expectation, budget, etc. during discussion with the customer ,

**UNIT - III**

**[11 LECTURES]**

Create relevant solutions to meet customer requirements, develop the working calculation sheet outlining the broad estimate for the solar lighting solutions.

**UNIT- IV**

**[12 LECTURES]**

Prepare the cost benefit analysis for solar lighting solutions, prepare a proposal for solar lighting solutions, prepare a pitch for the customer and close the sale, create and manage a pipeline of potential customers.



**RECOMMENDED REFERENCES:**

1. *Development of Solar and Wind Power in Karnataka and Tamil Nadu, Edition by Asian Development Bank*
2. *The Solar Economy: Renewable Energy for a Sustainable Global Future, Hermann Scheer,*
3. *Solar Revolution – The Economic Transformation of the Global Energy Industry Travis Bradford, The MIT Press.*
4. *The Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy: How to Design and Install Photovoltaic Solar Electric Systems 2017, Michael Boxwell.*

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RETM - 502

HEALTH AND SAFETY PRACTICES AT PROJECT SITE

TOTAL LECTURES REQUIRED: 45

UNIT - I

[12 LECTURES]

Adherence to safe working practices at wind project site, select the relevant protective clothing/equipment for specific tasks and work, state the name and location of relevant documents and people responsible for health and safety in the workplace, identify possible causes of risk at workplace and their mitigation measures, identify and follow warning signs on site.

UNIT - II

[11 LECTURES]

Establish safe working procedures at the workplace ensure safe working practices when working at heights, confined areas and trenches, identify methods of accident prevention in the work environment, follow safe operating procedures for lifting, carrying and transporting heavy objects & tools, inspect the work place on a regular basis for any signs of spillage, ensure safe storage of flammable materials and machine lubricating oil, apply good housekeeping practices at all times by removal/disposal of waste products, inform relevant authorities about any abnormal situation/behavior of any equipment/system promptly,

UNIT - III

[11 LECTURES]

Fire safety and tackling emergency situations - exhibit the use of various appropriate fire extinguishers on different types of fires correctly, demonstrate rescue techniques applied during fire hazard, administer appropriate first aid to victims where required e.g. in case of bleeding, burns, choking, electric shock, poisoning etc., respond promptly and appropriately to an accident situation or medical emergency in real or simulated environments

UNIT - IV

[11 LECTURES]

Participate in emergency procedures: raising alarm, safe/efficient, evacuation, correct means of escape, correct assembly point, roll call, correct return to work f. report the accident to the relevant authority in the prescribed format.

**RECOMMENDED REFERENCES:**

1. *The Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy: How to Design and Install Photovoltaic Solar Electric Systems 2017*, Michael Boxwell
2. *Industrial Safety Management 1st Edition (English, Hardcover, L M Deshmukh)*

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3. *Gap Analysis of Env., Health & Safety Mgt. Systems - Highway Project (English, Paperback, Ziauddin Akbar).*
4. *The Grid: A Journey Through the Heart of Our Electrified World, Phillip F. Schewe.*

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**RETM - 503**

**ENERGY IN BUILDINGS**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. Concepts and techniques of energy efficient buildings design features.
2. Concepts and techniques of solar passive heating and cooling systems.
3. Concepts and techniques of day lighting and electrical lighting, heat control of buildings.

**UNIT- I**

**[12 LECTURES]**

Climate and shelter, Historic buildings, Modern architecture, Examples from different climate zones, Thermal comfort, Solar geometry and shading, Heating and cooling loads, Energy estimates and site planning.

**UNIT- II**

**[10 LECTURES]**

Passive solar heating, Direct gain, Thermal storage wall, Sunspace, Convective air loop, Passive cooling, Ventilation, Radiation, Evaporation and Dehumidification, Mass effect, Design guidelines.

**UNIT - III**

**[11 LECTURES]**

Energy conservation in building: Day lighting, Water heating and photovoltaic systems Air conditioning, HVAC equipments, Computer packages for thermal design of buildings and performance prediction, Monitoring and instrumentation of passive buildings

**UNIT- IV**

**[12 LECTURES]**

Control systems for energy efficient buildings, Illustrative passive buildings, Integration of emerging technologies, Intelligent building design principles, Various Energy Efficiency Rating Systems for Buildings, LEEDS, BEE & GRIHA Rating Systems Energy Conservation Building Code.

**RECOMMENDED REFERENCES:**

1. Sodha M., Bansal, N.K., Bansal, P.K., Kumar, A. and Malik, M.A.S., "Solar Passive Buildings", Pergamon Press, 1986.



2. Koenigsberger, O.H., Ingersoll, T.G., Mayhew Alan and Szokolay, S. V., "Manual of Tropical Housing and Building part 1: Climatic Design", OLBN 0 00212 0011, Orient Longman Limited, 1973.
3. Bureau of Indian Standards, I.S. 11907 -1986 Recommendations for calculation of Solar Radiation Buildings, 1986.
4. Givoni, B., "Man, Climate and Architecture", Elsevier, Amsterdam, 1986. 3. Smith, R. J., Phillips, G.M. and Sweeney, M. "Environmental Science", Longman Scientific and Technical, Essex, 1982.
5. J.A. Clarke, Energy Simulation in Building Design (2e) Butterworth 2001.
6. J.K. Nayak and J.A. Prajapati Handbook on Energy Conscious Buildings, Solar Energy Control MNES, 2006.
7. Energy Conservation Building Codes 2006; Bureau of Energy Efficiency.
8. J.R. Williams, Passive Solar Heating, Ann Arbor Science, 1983.
9. R.W. Jones, J.D. Balcomb, C.E. Kosiewicz, G.S. Lazarus, R.D. McFarland and W.O. Wray, Passive Solar Design Handbook, Vol.3, Report of U.S. Department of Energy (DOE/CS-0127/3), 1982.
10. M.S. Sodha, N.K., Bansal, P.K. Bansal, A.Kumar and M.A.S. Malik. Solar Passive Building, Science and Design, Pergamon Press, 1986.
11. J.L. Threlkeld, Thermal Environmental Engineering, Prentice Hall, 1970.

RETM - 504

ENERGY MODELING AND PROJECT MANAGEMENT

TOTAL LECTURES REQUIRED: 45

LEARNING OBJECTIVES

1. To familiarize the students with the methods of modeling and analysis of solar thermal and PV systems.
2. To understand the Mathematical modeling development methods, Quantitative techniques, various numerical methods to solve equations, Software tools to solve problems.

UNIT -I

[10 LECTURES]

**Modeling:** Testing for proportionality, Modeling change with difference equations, examples- A saving certificate, mortgaging a home, Approximating change with difference equations, examples growth of yeast culture, growth of yeast culture revisited, Solutions to Dynamical systems, examples- A saving certificate revisited, sewage treatment.

UNIT-II

[10 LECTURES]

Systems of difference equations , examples- A car rental company, discrete epidemic models, Modeling process- mathematical models, example- vehicular stopping distance, modeling using proportionality, example- kepler's third law.

UNIT-III

[12 LECTURES]

Modeling process- modeling using geometric similarity, example- rain drops from a motionless cloud, automobile gasoline mileage, body weight and height, strength and agility, Model fitting- Fitting models to data graphically, Analytic methods of model fitting, Applying the Least- Squares Criterion, choosing a best model.

UNIT - IV

[13 LECTURES]

Experimental Modeling- Introduction, harvesting in the Chesapeake Bay and other one term models, example harvesting Blue fish and harvesting Blue crabs, Higher order Polynomial models, example- Elapsed time of a tape recorder, Smoothing- Low Polynomial models, example- Elapsed time of a tape recorder revisited, HOMER software, Power system modeling.



**RECOMMENDED REFERENCES:**

1. Bender E.A., "Introduction to Mathematical Modeling", Dover Publ., 2000.
2. Meyer W.J., "Concepts of Mathematical Modeling", Dover Publ., 2004.
3. Dym C.L., "Principles of Mathematical Modeling", Elsevier, 2004.

RETM - 505

ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

TOTAL LECTURES REQUIRED: 45

LEARNING OBJECTIVES

1. To enable the students to understand the concept of generation, transmission and distribution of energy & to enlighten them on the power factor improvement and transformer distribution.
2. To get acquainted about factors affecting motor performance, rewinding and motor replacement issues & energy saving opportunities with energy efficient motors.
3. To enrich students to identify compressed air systems, types of air compressor, fans & blowers & its types, lighting systems & types of lamp and light source, compressor efficiency and its components, factors affecting performance and efficiency.
4. To enrich students with the knowledge regarding energy efficient technologies in electrical systems.

UNIT-I

[11 LECTURES]

**Electrical System:** Introduction, Generation, Transmission and Distribution of Electricity, IE (Indian Electricity) Rules, Important Equipments, Electricity Billing, Electrical Load Management and Maximum Demand Control, Maximum Demand, Contracted Maximum Demand, Connected Load.

UNIT-II

**Electric Motors:** Introduction, Types of Motors, Direct Current Motors (DC Motors), Synchronous Motors, Induction Motors, Power Factor, Motor Efficiency and its Losses, Factors Affecting Motor Performance, Rewinding and Motor Replacement Issues, Energy Saving Opportunities with Energy Efficient Motors.

UNIT -III

[11 LECTURES]

**Lighting System:** Introduction, Basic Terms in Lighting Systems and Features, Lamp Types and their Features, Recommended Illuminance Levels for Various Tasks / Activities / Locations, Methodology of Lighting System Energy Efficiency Study, Energy Efficient Replacement Options, Good Practices in Lighting, Installation of Compact Fluorescent Lamps (CFL's) in Place of Incandescent Lamps, Installation of LED Panel Indicator Lamps in Place of Filament Lamps.



**UNIT-IV**

**[12 LECTURES]**

**Energy Efficient Technologies in Electrical Systems:** Maximum Demand Controllers, Automatic Power Factor Controllers, Voltage Control, Kilovar Control, Automatic Power Factor Control Relay, Intelligent Power Factor Controller (IPFC), Energy Efficient Transformers, Electronic Ballast, Role of Ballast, Conventional vs. Electronic Ballasts.

**RECOMMENDED REFERENCES:**

1. Eastop T.D & Croft D.R, *Energy Efficiency for Engineers and Technologists*, Logman Scientific & Technical, ISBN-0-582-03184, 1990.
2. Reay D.A, *Industrial Energy Conservation*, 1st edition, Pergamon Press, 1977.
3. Larry C Whitetal, *Industrial Energy Management & Utilization*.
4. *Power System Engineering 2nd Ed.* D P Kothari, I J Nagrath, Tata McGraw-Hill Co 2008

**RETM - 506**

**HYDROGEN ENERGY AND FUEL CELLS**

**TOTAL LECTURES REQUIRED: 45**

**LEARNING OBJECTIVES**

1. Methods of hydrogen production, storage and utilization.
2. Basics of fuel cell technology.
3. Major types of fuel cells and their modes of operation.
4. Application of fuel cells in power cogeneration and heat and power cogeneration.

**UNIT -I**

**[12 LECTURES]**

Fuel Cell Basics Fuel cell definition, Difference between batteries and fuel cells, fuel cell history, components of fuel cells, principle of working of fuel cells Fuel cell thermodynamics - second law analysis of fuel cells, efficiency of fuel cells fuel cell electrochemistry - Nernst equation.

**UNIT - II**

**[10 LECTURES]**

Butler-Volmer equation , Fuel cell types Classification by operating temperature/electrolyte type, Fuel Cell Performance, Activation, Ohmic and Concentration over potential.

**UNIT-III**

**[12 LECTURES]**

Fuel cell design and components Cell components, stack components, system components Overview of intermediate/high temperature fuel cells - Solid oxide fuel cells (SOFC), Molten carbonate fuel cells (MCFC), Phosphoric acid fuel cells (PAFC) Polymer Electrolyte fuel cells ,Heat and mass transfer in polymer electrolyte fuel cells, water management in PEFCs, Current issues in PEFCs, Direct methanol fuel cells (DMFC) - Electrochemical kinetics methanol oxidation, Current issues in MFCs, Fuel crossover in DMFCs, Water management in DMFCs, high methanol concentration operation, limiting current density.

**UNIT -IV**

**[11 LECTURES]**

**Hydrogen Energy:** Its merit as a fuel, Applications Hydrogen production methods Production of hydrogen from fossil fuels, electrolysis, thermal decomposition, photochemical and photocatalytic methods Hydrogen storage methods Metal hydrides, metallic alloy hydrides.



**RECOMMENDED REFERENCES:**

1. Kettani, M.A., *Direct energy conversion*, Addison-Wesley, Reading, Mass, 1970
2. Angrist S.W., *Direct Energy Conversion*. 4th Ed. Allyn And Bacon, Boston, 1982
3. Green M.A., *Solar Cells*, Prentice-Hall, Englewood Cliffs, 1982
4. *Hand book Batteries and Fuel Cells*. Linden, McGraw Hill, 1984.
5. J Larminie and A Dicks, *Fuel Cell Systems Explained*, 2nd Edition, Wiley, 2003
6. Xianguo Li, *Principles of Fuel Cells*, Taylor and Francis, 2006
7. S Srinivasan, *Fuel Cells: From Fundamentals to Applications*, Springer
8. O'Hayre, SW Cha, W Colella and FB Prinz, *Fuel Cell Fundamentals*, Wiley, 2005
9. A Faghri and Y Zhang, *Transport Phenomena in Multiphase Systems*, Elsevier 2006
10. *Hand Book of Batteries and Fuel cells*, 3rd Edition, Edited by David Linden and Thomas. B. Reddy, McGraw Hill Book Company, N.Y. 2002
11. *Principles of Fuel Cells*, by Xianguo Li, Taylor & Francis, 2006
12. *Fuel Cells, Principles and Applications*, Viswanathan, B. and Scibioh, Aulice M, Universities Press, 2006.

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RETM - 507

SMART AND MICRO GRID

TOTAL LECTURES REQUIRED: 45

LEARNING OBJECTIVES

1. To know, list and classify the basic terms of a Power System Grid; Explain the importance and objectives of the various dispersed generation units.
2. To describe by drawing a block diagram and explain the operation of the basic part of a smart grid (namely the Microgrid) & to quantify its operation.
3. To know, understand and explain the concept of a smart grid.

UNIT - I

[11 LECTURES]

**Introduction to Smart Grid:** Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grids, Introduction to EMS, HVDC, FACTS.

UNIT - II

[13 LECTURES]

**Smart Grids and Smart cities:** Overview of Smart Grid, Smart City program design, Application and technology demonstration module, Deliverables of Smart Grid- Smart City modules, Governance structure, funding arrangements and process, SMART GRID BUSINESS.

UNIT - III

[10 LECTURES]

**Basics of Microgrid:** Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids.

UNIT - IV

[11 LECTURES]

**Modes of Operation and Control of Microgrid:** grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, microgrid communication infrastructure, Power quality issues in microgrids.



**RECOMMENDED REFERENCES:**

1. Vehbi C. Güngör, Dilan Sahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, *Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions On Industrial Informatics*, Vol. 7, No. 4, November 2011. 34
2. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang "Smart Grid – The New and Improved Power Grid: A Survey", *IEEE Transaction on Smart Grids*,
3. Stuart Borlase "Smart Grid :Infrastructure, Technology and Solutions", *CRC Press 2012*.
4. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", *Wiley*.
5. "Voltage Source Converters in Power Systems: Modeling, Control and Applications", *Amirnaser Yezdani, and Reza Iravani, IEEE John Wiley Publications*.
6. "Power Switching Converters: Medium and High Power", *DorinNeacsu, CRC Press, Taylor & Francis, 2006*.
7. "Solar Photo Voltaics", *Chetan Singh Solanki, PHI learning Pvt. Ltd., New Delhi, 2009*

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18.1.2020*

*H.S. Kumar*

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RETM - 508

ENERGY EFFICIENCY IN THERMAL UTILITIES

TOTAL LECTURES REQUIRED: 45

LEARNING OBJECTIVES

1. To understand the main constituents of boiler feed water, classification of boiler in to various types.
2. To study different water treatment methods, to examine types of refractories.
3. To understand the mechanism of heat transfer, determination of economic thickness of insulation.
4. To understand the need for cogeneration & examining functioning of various types of cogeneration systems.

UNIT - I

[13 LECTURES]

**Boilers:** Types, combustion in boilers, performance evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities.

**Steam System:** Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings.

UNIT -II

[11 LECTURES]

**Furnaces:** Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.

**Insulation and Refractories:** Insulation types and application, economic thickness of insulation, heat saving and application criteria, refractory types, selection and application of refractories, heat loss.

UNIT - III

[10 LECTURES]

**FBC Boilers:** Introduction, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, retro-fitting of FBC system to conventional boilers, saving potential.

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**UNIT -IV**

**[11 LECTURES]**

**Cogeneration:** Definition, need, application, advantages, classification, saving potential. Waste Heat Recovery: Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential.

**RECOMMENDED REFERENCES:**

1. George Polimeros, *Energy Cogeneration Hand Book for Central Plant Design*, Industrial Press inc, Newyork, 1981
2. M.M.El- Wakil, *Power Plant Technology*, McGraw Hill, 1984
3. Chapters in a number of books on *Power Plant Engineering and Thermodynamics*
4. Eastop, T.D. & Croft D.R, "Energy efficiency for engineers and Technologists", 2nd Edition, Longman Harlow, 1990.
5. O'Callaghan, Paul W, "Design and Management for energy conservation", Pergamon,1993.
6. Osborn, peter D, "Handbook of energy data and calculations including directory of products and services", Butterworths, 1980.
7. Charles H.Butler, *Cogeneration*, McGraw Hill Book Co., 1984.
8. Horlock JH, *Cogeneration - Heat and Power, Thermodynamics and Economics*, Oxford, 1987
9. *IEEE Bronze Book: IEEE Standard 739-1984 - Recommended Practice for Energy Conservation and Cost Effective Planning in Industrial Facilities*, IEEE Publications, 1996.
10. A.P.W. Thumann: *Plant Engineers and Managers Guide to Energy conservation*, 7e, UNR, 1977.

*G. Lakshmi*  
18-1-2020

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**RETM - 509**

**WORKSHOP PRACTICES - II**

**COURSE DESCRIPTION**

Overview of state-of-the-art solar technology, development and research in the project area.

Pre-design of innovative solar thermal, PV and hybrid systems and their components with realistic constraints.

Analysis of system performance, economics, and assessment of environmental impact.

Interim report presentation.

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*H.S. Kumar*

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**SEMESTER VI (DEGREE COURSE)**

**RETM - 601**

**INDUSTRIAL TRAINING**

**COURSE DESCRIPTION**

Evaluation of Industrial Training shall be done at the end of VI semester and the students will have to submit a report on his / her training work as per the Regulation for B.Voc. The student may select any appropriate industry & is expected to work under the guidance of a project guide for at least a period as decided. The training shall have two guides. One in the participating organization (industry) who is the external guide and the other shall be one of the faculty members from Department who is the internal guide. The report should be submitted in five copies to the B.Voc Course Coordinator. These copies shall be distributed to the External Examiner, Internal Examiner, Project guide and Candidate.

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**RETM - 602**

**MAJOR PROJECT**

**COURSE DESCRIPTION**

Project evaluation shall be done at the end of VI Semester and the students will have to submit a dissertation on his / her project work as per the Regulation for B.Voc. The problem may be selected from an appropriate Industry or Institution. The candidate is expected to work under the guidance of a project guide for at least for a period as decided. In case the project work is taken up in an external Industry/Institution, the project shall have two guides. One in the participating organization (Industry/Institution) who is the external guide and the other shall be one of the faculty members from Department who is the internal guide. The dissertation should be submitted in five copies to the B.Voc Course Coordinator. These copies shall be distributed to the External Examiner, Internal Examiner, Project guide (Faculty), Library and the Candidate.

**Evaluation of Project Work:**

The project evaluation committee shall be responsible for the project work evaluation. The project guide (faculty from department) shall be the internal examiner. The external examiner shall be a technical expert in the concerned subject form any organization other than that of the project guide and is selected form the panel of experts submitted by the Course Coordinator. The dissertation shall be evaluated by the external examiner. Five bound copies along with a soft copy of the dissertation shall be submitted to the Head of the Department/Coordinator within the last date prescribed by the Department / School for the purpose. The project work shall be evaluated through presentations and viva voce. The grade/marks shall be given to the students according to the level and quality of work and presentation/documentation.

*Gothakar*  
18.1.2020

*H. K. Raw*

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**PT. RAVISHANKAR SHUKLA UNIVERSITY**

**Centre for Basic Sciences**

**Syllabus of**

**Integrated M. Sc. : Biology Stream**

**[Choice and Credit Based System]**

**Semester Examination**

**SESSION 2015-2020**

# Integrated M. Sc. : Biology Stream

[Choice and Credit Based System]

Scheme of Examination: Session 2015-20

(P: Physics, M: Mathematics, C: Chemistry, B: Biology, G: General, H: Humanities CB: Chemistry Biology, PCB: Physics Chemistry Biology, MB: Maths for Biology)

## FIRST YEAR [July 2015 to June 2016]

### SEMESTER-I

Subject	Subject	Contact hrs/per week Theory + Tutorials	Credits
B 101	Biology I (Introductory Biology)	[2 +1]	3
C 101	Chemistry I (Structures & Bonding)	[2 +1]	3
P 101	Physics I (Classical Physics)	[2 +1]	3
MB101	Mathematics I	[2 +1]	3
G 101	Computer Basics	[2 +1]	3
H 101	Communication Skills	[2 +0]	2
		Contact hrs/per week Lab	Credits
BL101	Biology Laboratory	[4]	2
CL 101	Chemistry Laboratory	[4]	2
PL 101	Physics Laboratory	[4]	2
GL 101	Computer Laboratory	[4]	2
			<b>25</b>

### SEMESTER-II

Subject	Subject	Contact hrs/per week Theory + Tutorials	Credits
B 201	Biology II (Introduction to Macromolecules)	[2 +1]	3
C 201	Chemistry II (Chemical thermodynamics)	[2 +1]	3
P 201	Physics II (Electricity, Magnetism & Optics)	[2 +1]	3
MB101	Mathematics II (Linear Algebra, Calculus of several variables)	[2 +1]	3
G 201	Electronics & Instrumentation	[2 +1]	3
G 202	Glimpses of Contemporary Science	[2 ]	2
		Contact hrs/per week Lab	Credits
BL 201	Biology Laboratory	[4]	2
CL 201	Chemistry Laboratory	[4]	2
PL 201	Physics Laboratory	[4]	2
GL 201	Electronics Laboratory	[4]	2
			<b>25</b>



**SECOND YEAR [July 2016 to June 2017]****SEMESTER-III**

Subject	Subject	Contact hrs/per week Theory + Tutorials	Credits
CB301	Essential Mathematics for Chemistry & Biology	[3 +1]	4
CB 302	Biochemistry – I	[3 +1]	4
B 301	Cell Biology – I	[3 +1]	4
CB 303	Organic Chemistry-I	[3 +1]	4
H 301	World Literature	[2 +0]	2
H302	History & Philosophy of Science	[2 +0]	2
		<b>Contact hrs/per week Lab</b>	<b>Credits</b>
BL 301	Biology Laboratory	6	3
GL 301	Applied electronics laboratory	4	2
			<b>25</b>

**SEMESTER-IV**

Subject	Subject	Contact hrs/per week Theory + Tutorials	Credits
B 401	Cell Biology – II	[3 +1]	4
B 402	Biochemistry – II	[3 +1]	4
CB 401	Introductory Spectroscopy (UV-vis, fluorescence, IR, Raman, NMR)	[3 +1]	4
PCB 401	Physical & Chemical kinetics	[3 +1]	4
G 401	Statistical techniques and Applications	[3 +1]	4
		<b>Contact hrs/per week Lab</b>	<b>Credits</b>
BL 401	Biology Laboratory	6	3
GL 401	Computational laboratory and Numerical Methods	4	2
			<b>25</b>

**THIRD YEAR [July 2017 to June 2018]****SEMESTER-V**

Subject	Subject	Contact hrs/per week Theory + Tutorials	Credits
B 501	Genetics	[3 +1]	4
B 502	Molecular Biology	[3 +1]	4
B 503	Biodiversity	[3 +1]	4
CB 501	Analytical Chemistry	[3 +1]	4
G 501	Earth Sciences and Energy & Environmental Sciences	[3 +1]	4
		<b>Contact hrs/per week Lab</b>	<b>Credits</b>
BL 501	Biology Laboratory	10	5
			<b>25</b>

**SEMESTER-VI**

Subject	Subject	Contact hrs/per week Theory + Tutorials	Credits
B 601	Immunology	[3 +1]	4
B 602	Animal Physiology	[3 +1]	4
B 603	Plant Physiology	[3 +1]	4
B 604	Microbiology	[3 +1]	4
CB 601	Biophysical Chemistry	[3 + 0 ]	3
H601	Ethics of Science and IPR	[2 + 0]	2
		Contact hrs/per week Lab	Credits
BL 601	Biology Laboratory	8	4
			<b>25</b>

**FOURTH YEAR [July 2018 to June 2019]****SEMESTER-VII**

Subject	Subject	Contact hrs/per week Theory + Tutorials	Credits
B 701	Neurobiology	[3 +1]	4
B 702	Immunology – II	[3 +1]	4
B 703	Developmental Biology	[3 +1]	4
B 704	Imaging technology in biological research	[3 +1]	4
BPr 701	Reading Project	-	4
		Contact hrs/per week Lab	Credits
BL 701	Advanced Biology Laboratory	[5 + 5]	5
			<b>25</b>

**SEMESTER-VIII**

Subject	Subject	Contact hrs/per week Theory + Tutorials	Credits
B 801	Virolog	[3 + 1]	4
B 802	Biotechnology – I	[3 + 1]	4
B 803	Bioinformatics	[3 + 1]	4
B 804	Biotechnology – II	[3 + 1]	4
		Contact hrs/per week Lab	Credits
BL 801	Advanced Biology Laboratory	[5 + 5]	5
BPr 800	Project	-	4
			<b>25</b>



**FIFTH YEAR [July 2019 to June 2020]****SEMESTER-IX**

Subject	Subject	Contact hrs/per week Lab	Credits
BPr 901	Project	-	20
			<b>20</b>

**SEMESTER-X**

Subject	Subject	Contact hrs/per week Lab	Credits
E 1001	Electives I	[3 + 2]	5
E 1002	Electives II	[3 + 2]	5
E 1003	Electives III	[3 + 2]	5
E 1004	Elective IV	[3 + 2]	5
			<b>20</b>

**Total Credits: 240****Electives:**

1. Toxicology and clinical research
2. Molecular modeling and drug design
3. Ethology
4. Parasitology
5. Reproductive biology
6. Occupational diseases (infectious incl)
7. Plant pathology
8. Plant communication
9. Animal migration
10. Commercial products from plants and animals
11. Biology of food industry
12. Transgenics
13. Ethical issues in biology and medicine
14. Physical biology
15. Astrobiology
16. Biology of traditional medicines
17. Translational biology
18. Science writing and communication
19. Forensic science
20. Epigenetics
21. On-line courses

## FIRST YEAR

### Semester – I [July- December 2015]

#### B 101: Biology I (Introductory to Biology)

##### Unit-I

Life: History and origin of life, Concepts of biological evolution, natural selection, speciation.  
Classification of living things: Classification and domains of life, Prokaryotes and Eukaryotes,  
Taxonomy of plants, animals and microorganisms.

##### Unit-II

Ecology & Ecosystem: Concept of ecology and ecosystem, ecological succession, ecosystem dynamics, flow of ecology and matter, biogeochemical cycling, ecosystem changes, biotic and biotic factors and stresses, food web, adaptation of individual organism to the environment through genetic changes.

##### Unit-III

Cell Biology: Discovery of cell, cell theory, classification of cell types, cell membrane, cell-cell interactions, energy and metabolism, respiration, photosynthesis, sexual reproduction.

##### Unit-IV

Cell Division and System Development: cell cycle, mitosis, meiosis, mechanism of development (stem cells), formation of tissues.

##### Unit-V

Physiology- Body Systems: Digestive system, circulatory system, Lymphatic system, nervous system, respiratory system, sensory system, homeostasis.

#### Books Recommended:

S.No.	Author	Book
1	Neil A Campbell and JB Reece ( 2007)	Biology with Mastering Biology (8 <sup>th</sup> Edition)
2	NA Campbell, JB Reece, MR Taylor and EJ Simon (2008)	Biology: Concepts & Connections with biology (6 <sup>th</sup> Edition)
3	Charles Darwin (2008)	On the Origin of Species
4	B Alberts, D Bray, K Hopkin and AD Johnson (2009)	Essential Cell Biology
5	Rene Fester Kratz (2009)	Molecular and Cell Biology For Dummies
6	MJ Behe (2006)	Darwin's Black Box: The Biochemical Challenge to Evolution
7	SD Garber (2002)	Biology: A Self-Teaching Guide, (2 <sup>nd</sup> Edition)

#### C 101: Chemistry –I [Structure & Bonding]

##### Unit-I

Atomic spectra, Bohr's theory of atomic structure, Sommerfeld's theory for complex electron spin and magnetic quantum number, Pauli exclusion principle, Hund's rule, electron configuration of elements, Sequence of energy levels and Periodic Table.



Size of atoms and ions, ionization energy, electron affinity, electronegativity – values by Pauling, Mulliken and Allred-Rochow, Metallic character, variable valence and oxidation states, horizontal, vertical and diagonal relationships in the periodic table.

Atomic Nucleus: Fundamental particles, classification of nuclides, nuclear stability, the neutron to proton ratio  $N/Z$ , nuclear potential, binding energy, exchange force. Radioactivity and radioactive elements, radioactive decay and decay kinetics.

#### Unit-II

The covalent bond - the Lewis theory, Octet rule and its limitations. Shapes of the molecules – Sidgwick – Powell theory. Valence shell electron pair (VSEPR) theory, effect of lone pair and electronegativity, isoelectronic principle, examples to apply VSEPR theory. Valence bond theory. Hybridization. Bond length, bond angle & dihedral angle, d-orbital participation in molecular bonding, sigma and pi bonding. Molecular orbital method – Linear combination of atomic orbitals (LCAO), MO treatment for di- and tri-atomic molecules and involving delocalized pi-bonding. Conjugation & aromaticity.

#### Unit-III

Metallic and organometallic bonds – general properties. Coordinate bond- coordination complexes. Physical properties and molecular structures – polarizability and dipole moments, melting point, solubility and acid-base properties, Intermolecular forces (dipole-dipole interaction) Hydrogen bonding and vander Waals's forces.

#### Unit-IV

Inductive and field effects and bond dissociation energy.  $p\pi-d\pi$  bonding. Delocalization – cross conjugation, resonance. Aromaticity and Huckel's rule – systems of  $4n$  and  $4n+2$  electrons, antiaromaticity . Resonance and Hyperconjugation. Reaction mechanism: Types of mechanisms, Arrhenius theory, collision theory, types of reactions, redox reactions, displacement and addition reactions, thermodynamic and kinetic requirements.

#### Unit-V

Hammond postulate, Curtin-Hammett principle, transition states and intermediates, carbocations, carbanions, free radicals, methods of determining mechanisms, isotopic effects. General concepts: Oxidation number and oxidation states, Oxidation – reduction reactions and the use of reduction potential, Bronsted acids and bases, gas phase vs. solution acidity, solvent levelling effects, hardness and softness, surface acidity.

#### Books Recommended:

S.No.	Author	Book
1	J.D.Lee	Concise Inorganic Chemistry, 4th Edition, ELBS, 1991
2	P.W.Atkins	Physical Chemistry, Oxford University Press, 7th Edition, 2006
3	G.M.Barrow	Physical Chemistry, 5th Edition, Tata McGraw-Hill, 1992
4	R. T. Morrison, R. N. Boyd, P. Sykes	Organic Chemistry, Prentice Hall of India
5	G.W. Castellan	Physical Chemistry, 3rd Ed. Addison - 1993

### P 101 Physics- I (Classical Physics)

#### Unit-I

Concepts of energy and mass, Linear kinematics and dynamics. Concept of force: Conservative and non-conservative forces, Friction. Conservation of momentum, energy, and angular momentum. Work-energy theorem, Centre of mass, moment of inertia.

#### Unit-II

Rotational kinematics and dynamics, Rigid body motion. Impulse and collisions, Central forces, Kinetic theory of gases, Equipartition of energy.

**Unit-III**

Free oscillations in one, two, and many degrees of freedom. Linearity and superposition principle. Normal modes; Transverse and longitudinal modes

**Unit-IV**

General notion of a continuous string; Resonance; Coupled pendula and oscillators, Normal coordinates.

**Unit-V**

Probability (chance, fluctuations, random walk, probability distribution, uncertainty principle); Curvilinear Coordinates, Vector calculus (differentiation and integration, gradient, divergence, curl, Green's theorem, Gauss' theorem, Stokes' theorem); Fourier series (an introduction).

**Books Recommended:**

S.No.	Author	Book
1	R. P. Feynman, R. B. Leighton, M. Sands	The Feynman lectures in Physics" Volume-1
2	D. Kleppner and R. Kolenkow	An introduction to mechanics
3	C. Kittel, W. D. Knight and M. A. Ruderman	Mechanics [Berkeley Physics Course Vol. 1]
4	F. S. Crawford	Waves [Berkeley Physics Course Volume 3]

**MB 101: Mathematics – 1****Unit-I**

The idea of derivative of a function, polynomials, slope and tangent line, derivatives of trigonometric functions, product and quotient rules. Notion of limits and continuous functions. Elementary results pertaining to limits of functions: product and quotient rules. Higher order derivatives, examples. Maxima and minima, curve tracing, Conic sections: circle, ellipse, hyperbola and parabola; equations, focus, directrix, latus rectum. Generalised conic section equation, exponential and logarithmic functions and their derivatives.

**Unit-II**

Application of derivatives to root finding: Newton's method (to be supplemented by an introduction to iterative processes). Mean value theorem of differential calculus, Rolle's theorem, applications. l'Hôpital's rule. The chain rule of differentiation, Implicit differentiation, Inverse functions and their derivatives, Inverse trigonometric functions, Applications.

Concept of infinite series, Geometric series, convergence tests; Taylor series, Maclaurin series for elementary functions, power series, simple applications.

**Unit-III**

Notion of an integral, integral as limit of sums; anti-derivatives, area under a curve, definite integrals, indefinite integrals. Rules of integration: integration by parts, integration by substitution. Properties of definite integrals including mean value theorem for integral calculus. Fundamental theorem of integral calculus. Integrals involving polynomial, exponential, logarithmic, trigonometric, inverse trigonometric functions. Application of integrals to areas, length of a plane curve, volumes of solids of revolution.

**Unit-IV**

Complex numbers: real and imaginary parts, The complex plane, Complex algebra (complex conjugate, absolute value, complex equations, graphs, physical applications). Elementary functions of complex numbers, Euler's formula, Powers and roots of complex numbers. The exponential and trigonometric functions, Hyperbolic functions, Logarithms, Complex roots and powers, Inverse trigonometric and hyperbolic functions, Some applications.



**Unit-V**

Separable equations, Linear first order equations, Other methods for first order equations, Second order linear equations with constant coefficients and both zero and non-zero right hand side, Other second order equations.

**Books Recommended:**

S.No.	Author	Book
1	Gilbert Strang (MIT Courseware)	Calculus
2	M. Weir, J. Hass and F. R. Giordano (Pearson Education)	Calculus

**H 101: Communication Skills****Unit-I**

An interactive session (with examples) on what is communication, communication in the natural and civilized worlds, types of human communication: visual / non-verbal / verbal, written / spoken, etc

**Unit-II**

An overview of mass media; a brief discussion of their types (with examples). The concepts of facilitating factors, barriers, and filters in communication; the seven C's of effective communication.

**Unit-III**

Verbal communication: How to speak / listen effectively (in interpersonal communication), types of public speaking, tips for effective public speaking, how to make effective presentations. The role of written text in communication,

**Unit-IV**

Types of writing (academic/creative/general; formal/informal etc.) with examples of good/bad writing and their analysis. Introduction to letter writing, with stress on formal correspondence; email do's and don'ts.

**Unit-V**

Academic writing- an overview; explanation of various terms used in academic writing; parts of a paper/thesis; aspects such as formal language, grammatical accuracy, etc. Common grammatical/punctuation errors and how to avoid them (example-based instruction)

**G101: Computer Basics****Unit-I**

Introducing LINUX: getting started;

**Unit-II**

FORTTRAN programming

**Unit-III**

LaTeX introduction (sufficient to make small documents); gnuplot - graph plotting and data fitting; xfig - simple drafting tool; MATHEMATICA - algebraic computations.

**Unit-IV****Projects on:**

Some of the projects done by the students are listed below; Predator-prey problem; Harmonic oscillator with friction Coupled pendulum

**Unit-V**

Projects on:

Testing random number generator; Brownian motion as a random walk problem; Sorting function and its application to making ranked lists, SUDOKU solver

**BL 101 Biology laboratory**

- 1) Introduction to Biology laboratory
- 2) Taxonomy
- 3) Methods of Classification  
Dichotomous key; Hierarchical Classification; Phylogenetic Classification
- 4) Natural Selection
- 5) Natural Selection using Daphnia
- 6) Concept of pH & Buffers:  
Hydrogen ion concentration in solution; Inorganic ion concentration in solutions  
Inorganic Buffers and Biological fluids; Henderson-Hasselbach equation
- 7) Media Preparation:  
Preparing and inoculating solid and liquid nutrient media for culturing microorganisms  
Pouring nutrient agar plates and streaking bacterial culture on solid media Inoculating nutrient broth with bacterial culture Preparing nutrient media
- 8) Introduction to Research Laboratory  
Different kinds of microbial plates, liquid growth media for microbes, Laminar air flow system, stem cells laboratory, Centrifuges, Spectrophotometer, Sonicator, PCR and Real-time PCR, Gel Documentation system, *Chlamydomonas* and *Drosophila* incubation systems, Stereomicroscope and various Incubators
- 9) Growth Curve:  
Generating a bacterial growth curve under various pH and environmental conditions (steady and shaking); Calculations of Growth rate constant ( $\mu$ ); Calculation of generation time
- 10) Enzyme Kinetics: To study an enzyme catalyzed reaction using hydroquinone as a substrate and peroxidase extracted from cabbage.
- 11) Introduction to Light Microscopy: Observing cells in a leaf peel using a compound microscope and to study the morphological characteristics of *Saccharomyces cerevesiae*.
- 12) Dye exclusion method of differentiating dead v/s live cells: To use a vital stain to distinguish dead and live yeast cells.
- 13) Staining and Observing human cheek cells: To carry out staining of epithelial cells from the mouth using acetocarmine and methylene blue stains.
- 14) Staining human blood cells: To observe human blood cell types by differential staining.
- 15) Plant anatomy: Relationship between plant anatomy and habitat.
- 16) Micrometry: Measuring size of a microscopic specimen.
- 17) Haemocytometer
- 18) Gram Staining: To differentiate bacteria cells by Gram staining.

**CL 101: Chemistry Laboratory**

Calibrations of pipette, burette, standard flasks etc., acid base titrations, recrystallization, thin layer chromatography, identification of organic functional groups, complexometric titrations based on EDTA complexation with metals, Synthesis of benzoic acid, diazotization etc.

**Books Recommended:**

S.No.	Author/Book
1	Vogel's Textbook of Quantitative Chemical Analysis (5th Edition; Longmann)
2	Vogel's Qualitative Inorganic Analysis (7th Edition)
3	ACS Journal of Chemical Education



### PL 101: Physics Laboratory -I

Introduction to experimental physics – conceptual and procedural understanding, planning of experiments; Plots (normal, semi-log, log-log); uncertainty / error in measurements and uncertainty / error analysis. Introduction to measuring instruments – concepts of standards and calibration; determination of time periods in simple pendulum and coupled strip oscillator system with emphasis on uncertainty in the measurements and accuracy requirements; study of projectile motion – understand the timing requirements; determination of surface tension of a liquid from the study of liquid drops formed under the surface of a glass surface; determination of Young’s modulus of a strip of metal by double cantilever method (use of traveling microscope); study of combination of lenses and nodal points and correspondence to a thick lens; study of thermal expansion of metal – use of thermistor as a thermometer; measurement of small resistance of a wire using Carey-Fosterbridge and determine electrical resistivity of the wire; study of time dependence of charging and discharging of capacitor using digital multimeter –use of semi-log plot.

#### Books Recommended:

S.No.	Author	Book
1	Worsnop and Flint	Advanced Practical Physics for Students

### GL 101 Computer Laboratory

History of computers; hardware basics. Concept of operating system; basic Unix/Linux commands; Office suite, including spreadsheets. Flowcharts; computer arithmetic. Simple FORTRAN programming mathematical operators, input, output from keyboard, library functions. Conditional statements - If-thenelse, Case, Go-to. Loops- Do loops, cycle, exit, nested loops. Arrays- 1 dimensional and multidimensional. Formatting - input and output. Input and output from file. Functions and Subroutines.; Creating HTML pages; Plotting utilities like GNU Plot.

## Semester – II [January - June 2016]

### B 201: Biology –II [Introduction to Macro Molecules]

#### Unit-I

Cell – Overview: Cellular organization, Biomembranes, Nucleus, Cytoplasmic organelles, Bacteriophages. Nucleic Acids, Genomes and Proteomics: Building blocks- nucleotides, DNA structure, RNA structure and function, chromatin structure, genome code, genes, repetitive DNA sequences.

#### Unit-II

Gene Transcription: Overview of gene expression, overview of transcription, gene’s regulatory elements, transcription mechanisms in prokaryotes and eukaryotes (a comparison).

#### Unit-III

Protein Structure and Function: Building blocks- amino acids, peptides, secondary structure, three dimensional structure, membrane proteins, miscellaneous proteins, enzymes.

#### Unit-IV

Cell Signaling: Overview, signaling via hydrophobic molecules, signaling via ion channels, Signaling via G-protein coupled receptors, signaling via cell surface enzymes, intracellular signaling.

#### Unit-V

Biotechnology: DNA cloning, Uses of recombinant DNA technology, Polymerase chain reaction (PCR), Production of recombinant proteins and SDS-PAGE.

**Books Recommended:**

S.No.	Author	Book
1	B Alberts, A Johnson, J Lewis, and M Raff	Molecular Biology of the Cell
2	J D. Watson, T A. Baker, S P. Bell, & A Gann	Molecular Biology of the Gene (6th Edition)
3	John Wilson and Tim Hunt (2007)	Molecular Biology of the Cell: The Problems
4	Benjamin Lewin (2007)	Genes IX (Lewin, Genes XI)

**C 201: Chemistry- II [Chemical Thermodynamics]****Unit-I**

Classification of system, intensive and extensive properties, equilibrium and Heat, work and energy, irreversible and reversible expansion work of an ideal First law of thermodynamics, heat content or enthalpy of a system; Thermochemistry – Enthalpy of a reaction, exothermic and endothermic

**Unit -II**

Second law of thermodynamics, Carnot cycle, entropy, entropy change and Free energy functions and Maxwell's relations, Gibb's Helmholtz relations, nonequilibrium states, reversible and irreversible processes. gas, internal energy in a cyclic process. heat capacities, Joule- Thomson effect, Adiabatic expansion of an ideal gas and work done. reactions, thermochemical equation, Kirchoff's equation, heat of reaction and flame temperature, heat of combustion, heat of solution, heat of neutralization, heat of fusion, heat of vaporization, Bond energy and dissociation energy, Hess's law and its applications. irreversible processes and Clausius inequality, entropy and available work. criteria of spontaneity and conditions of equilibrium, Heat capacity relations ( $C_p/C_v$  and  $C_p - C_v$ ), change of phase and Clapeyron equation, Trouton's rule.

**Unit -III**

Electrode potential and free energy, electrochemical series. Nernst heat Theorem and third law of thermodynamics, experimental Elements of statistical thermodynamics

**Unit -IV**

Chemical equilibrium and chemical potential ( $\mu$ ): chemical potential of an determination of entropy. ideal gas and gas mixture, Gibbs free energy and entropy of mixing, Chemical Phase equilibrium in simple systems: Equilibrium condition, stability of the Ideal solutions and colligative properties: ideal solutions, chemical potential equilibrium in a mixture of ideal gases and real gases, Equilibrium constants –  $K_x$  and  $K_c$  between ideal gases and pure condensed phase. Lechatelier principle and applications. phases of a pure substance, pressure dependence of  $\mu$  vs. T curves, Clapeyron equatons.

**Unit -V**

Phase equilibrium: solid- liquid, liquid-gas, solid-gas, phase diagram – water, carbondioxide, sulphur, Effect of pressure on the vapour pressure, the phase rule. of a solute in a binary ideal solution – Gibbs-Duhem equation, Colligative properties – freezing pointing depression, solubility, elevation of boiling point, Osmotic pressure, Vant Hoff equation.

**Books Recommended:**

S.No.	Author	Book
1	P.W. Atkins	Physical Chemistry, Oxford University Press, 7th Edition, 2006
2	G.W. Castellan	Physical Chemistry, 3rd Ed. Addison - Wesley/Narosa Publishing House, 1993
3	G.N.Lewis and Randall	Thermodynamics, (Revised by K.S.Pitzer and L.Brewer), International Students Edition,
4	K. Denbigh	The principles of Chemical Equilibrium
5	B. G. Kyle	Chemical & Process Thermodynamics



## P 201: Physics – II: [Electricity, Magnetism and Optics]

### Unit-I

Electrostatics: Coulomb's law and Gauss' law; Electrostatic potential, uniqueness theorem, method of images; Electrostatic fields in matter; Conductors and insulators; Capacitors and capacitance; Electric current.

### Unit-II

Magnetostatics: Biot – Savart law, Ampere's law; Electromagnetic induction; Mutual inductance and self inductance; Magnetic fields in matter.

### Unit-III

Displacement current; Maxwell's equations; Alternating current circuits; Electric and magnetic properties of matter; Plane electromagnetic waves in vacuum; Polarisation;

### Unit-IV

Energy and momentum in electromagnetic waves; electromagnetic radiation (qualitative); Dipole radiation formula; Larmor's formula for radiation due to accelerated charge (without proof); Synchrotron radiation (descriptive).

### Unit-V

Optics Interference of two beams and involving multiple reflections; Young's experiment, Fresnel's biprism, Lloyd's mirror, Optical instruments; Telescope and microscopes; Magnifying power and resolving power. Sources of light and spectra; Dispersion, polarization, double refraction; Optical activity.

### Books Recommended:

S.No.	Author	Book
1	Edward M. Purcell	Electricity and Magnetism Berkeley Vol. 2
2	Frank S. Crawford	Waves, Berkeley Vol. 3
3	Jenkins and White	Fundamentals of Optics
4	Feynman	Feynman Lectures Vol. 2

## MB 201: Mathematics – II [Linear Algebra, Calculus of Several variables]

### Unit I

Functions of several variables, partial derivatives, geometric interpretation, properties of partial derivatives, chain rule, applications. Elementary discussion on scalars and vectors, norm of a vector, dot product, projections. Linear equations and matrices, matrix operations. Concept of a determinant, its properties, evaluation of a determinant, cross product as a determinant, lines and planes. Elementary ideas of tensors.

### Unit II

Vector functions. Gradient of a function, geometric interpretation, properties and applications; divergence and curl of a vector function, geometric interpretation, properties and applications; higher derivatives, Laplacian. Line integrals. Double and triple integrals, their properties and applications to areas, volumes, etc.

### Unit III

Gradient theorem, Green's theorem, Stokes' theorem, divergence theorem, applications. Proofs of Stokes' and divergence theorems through physical examples (such as circulation in a 2 dimensional plane and accumulation of fluid in a given volume).

### Unit IV

Curvilinear coordinate systems, spherical and cylindrical coordinates, area and volume elements, illustrations. Gradient, divergence and curl in curvilinear coordinate systems.

**Unit V**

Introduction to linear algebra. Vector spaces, linear dependence and independence, notion of basis, and dimension, subspaces. Examples. More on matrices: special kinds of matrices, their properties. Eigenvalues and eigenvectors, secular determinant, characteristic polynomial. Eigenvalues and eigenvectors of a real symmetric matrix. Illustrative examples. Applications of linear algebra.

**Books Recommended:**

S.No.	Author	Book
1	Gilbert Strang (MIT Courseware)	Calculus
2	Thomas	Calculus
3	Howard Anton and Chris Rorres	Elementary Linear Algebra
4	Gilbert Strang (MIT Courseware)	Introduction to Linear Algebra
5	George B. Arfken and Hans J. Weber	Mathematical Methods for Scientists and Engineers

**G201- Electronics & Instrumentation****Unit-1**

Analog electronics: Introduction to passive electronic components -resistance, capacitance, inductance; Circuit theorems: Thevenin's theorem, Norton's theorem and Maximum power transfer theorem; basic concepts of semiconductor diode and transistor; application of Bipolar Junction Transistor (BJT) – biasing circuits: The CE configuration, fixed base bias, emitter bias, and potential-divider or voltage divider bias; CE amplifier, amplifier as a switch, concept of negative feedback.

**Unit-2**

Principle of DC power supply; half and full wave bridge rectifier, capacitor filter – ripple factor, concept of load and line regulation, concept of constant voltage source and constant current source; concept of short circuit protection and current limit protection; Zener regulator; concept of Switch Mode Power Supply (SMPS), power supply ICs, charge pump ICs for stepping up voltage and for bipolar supply.

**Unit-3**

Differential amplifier; Operational Amplifier (OPAMP): principle, basic characteristics and parameters relevant for general use; non-inverting and inverting amplifier, voltage follower, difference amplifier, summing amplifier, voltage controlled current source; OPAMP comparator, Schmidt trigger; Digital to Analog Converter (DAC) with weighted resistance and R-2R ladder network; Analog to Digital Converter (ADC); filters: low pass, high pass; band pass; Butterworth filter.

**Unit-4**

Digital electronics: Review of basic logic gates; DeMorgan's theorem, Use of NAND / NOR as universal building blocks; arithmetic circuits; binary addition, half adder, full adder, binary subtraction - 1s and 2s complement, controlled inverter, adder / subtracter, parity checker; Flip-Flops (FF): RS-FF, D-FF, JK-FF; counters and shift registers: binary counter, ripple counter.

**Unit-5**

Basic concepts of instrumentation, generalized instrumentation systems block diagram representation; Sensing elements: electrodes and transducers. Electrode-electrolyte interface, stability of electrode potentials, circuit models, external and internal electrodes, pH, pO<sub>2</sub> and pCO<sub>2</sub> electrodes. Transducer, definition, types, displacement, velocity, acceleration, pressure, temperature vibration, ultrasound etc., calibration, sensitivity and resolution.



**Books Recommended:**

S.No.	Author	Book
1	R. L. Boylestad, L. Nashelsky, K. L. Kishore, Pearson	Electronic Devices and Circuit Theory
2	Malvino and Bates	Electronic Principles
3	Donald A. Neamen, Tata McGraw Hill	Electronic Circuit Analysis and Design
4	David A. Bell	Electronic Devices and Circuits
5	Leach, Malvino and Saha	Digital Principles and Applications
6	R.P. Jain	Modern Digital Electronics, Tata McGraw-Hill (2003)
7	M. Morris Mano, Michael D. Ciletti	Digital Design, Pearson Education Asia, (2007)
8	Thomas L. Floyd	Digital Fundamentals, Pearson Education Asia (1994)
9	DVS Murthy	Measurement & Instrumentation
10	A.K. Sawhney	Electrical Measurements & Electronic Measurements

**G202- Glimpses of Contemporary Science****Unit-I**

Physics in life systems: size and scale, diffusion, cell locomotion, force generated by actin growth and flagellum rotatory motion, ion channels, resting potential across the membrane, nerve conduction velocity, action potential, macromolecules of life, random walk model of polymer, single molecular experiments, optical tweezers, magnetic tweezers.

**Unit-II**

Complex systems: dynamical chaos, logistic map, bifurcation, Universality, Feigenbaum constants, Mechanical demonstrations of chaos, Nanomechanical oscillators, Patterns, Reaction-diffusion systems, Nodal patterns, thermodynamics and human population, Falling leaves, Smoke ring physics.

**Unit-III**

At the turn of 1900: Silver threads, Discovery of the electron, Rutherford's nuclear atom Wien's law, Blackbody radiation and Max Planck's action.

**Unit-IV**

Astrophysics, Astrochemistry and Astrobiology

**Unit-V**

Quantum mechanics, atoms : Entanglement Light-atom interaction, Bringing atoms to rest, Laser tweezers, How bright is laser, Quantum computing.

**Books Recommended:**

S.No.	Author	Book
1	Darcy Wentworth Thompson	Growth and Forms
2	Rob Phillips	Physical biology of the cell
3	Harward Berg	Random walks in biology
4	L. Cooper	Physics: Structure and Meaning
5	R. P. Feynman, R. B. Leighton, and M. Sands	The Feynman Lectures on Physics vol. 3
6	S. Chandrasekhar	Introduction to the study of stellar structure

### BL 201: Biology Practical

1. Observing instruments to be used in semester II, their use and maintenance: (a) micro-pipettes, (b) tissue homogenizer, (c) electrophoresis apparatus, (d) centrifuges, (e) ultraviolet and visible (uv-vis) absorption spectrophotometer
2. Centrifugation of the cell contents at varying speeds such that the subcellular fractions separate out based on their density differences
3. Photosynthesis - floating leaf disc experiment under various conditions (light, dark & light - dark)
4. Visit to TIFR
5. Nucleic acid extraction - from plant & animal tissue using ethanol precipitation
6. Agarose gel electrophoresis
7. Analysis of DNA under various conditions – pH and Temperature
8. Protein extraction & separation using polyacrylamide gel electrophoresis (PAGE)
9. Carbohydrate extraction & estimation - extraction of sugars from grapes & estimation of the same by DNSA method
10. Protein extraction & estimation determination of total protein content in microorganisms by folin-ciocaltaeu method
11. Lipid extraction & separation - Extraction of total lipids from liver tissue & separation by thin layer chromatography
12. Separation of biomolecules using:
  - Adsorption chromatography; Partitioning of indicators in various solvent systems. ;
  - Separation of a mixture of solutes by partitioning; Separation of leaf pigments by paper chromatography
  - Separation of flower pigments by paper chromatography ; Reverse phase thin layer chromatography (PRTLTC) - Separation of photosynthetic pigments

### CL 201: Chemistry Laboratory

Colorimetric titrations, Beer Lambert law, Estimation of concentration by colorimetric methods, conductometric methods, estimation of concentration of acid base by pH meter, identification of inorganic anions and cations, finding of pKa values, short project of 2 weeks based on the experiments available in Journal of Chemical Education.

#### Books Recommended:

S.No.	Suggested text and references:
1	Vogel's Textbook of Quantitative Chemical Analysis (5th Edition; Longman)
2	Vogel's Qualitative Inorganic Analysis (7th Edition)
3	ACS Journal of Chemical Education

### PL 201- Physics Laboratory

Review of uncertainty / error analysis; least squares fit method; introduction to sensors / transducers; determination of 'g' (acceleration due to gravity) by free fall method; study of physical pendulum using a PC interfaced apparatus – study variation of effective 'g' with change of angle of plane of oscillation - investigation of effect of large angle of oscillation on the motion;

Study of Newton's laws of motion using a PC interfaced apparatus; study of conservation of linear and angular momentum using 'Maxwell's Wheel' apparatus; study of vibrations of soft massive spring; study of torsional oscillatory system; study of refraction in a prism - double refraction in calcite and quartz; study of equipotential surface using different electrode shapes in a minimal conducting liquid medium; determination of electrical inductance by vector method and study effect of ferromagnetic core and study the effect of non-linearity of inductance with current.



**Books Recommended:**

Worsnop and Flint      Advanced Practical Physics for Students

**GL 201 Electronics laboratory**

1. To study the Half wave & Full wave rectifier and study the effect of C filter.
2. To design a Single Stage CE amplifier for a specific gain and bandwidth.
3. Study of Operational amplifier in inverting and non-inverting mode.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. Measurement of pressure, strain and torque using strain gauge.

**Second Year****Semester – III [July - December 2016]****CB 301- Essential Mathematics for Chemistry & Biology****Unit-I**

Applications of Taylor series, Euler series

**Unit-II**

Review of first order ordinary differential equations, second order ODE's with constant coefficients, solutions by series expansion methods, introduction to partial differential equations,

**Unit-III**

Laplace's equation, separation of variables, Legendere differential equation and Legendere polynomials, important properties of Legendere polynomials, Hermite polynomials, Laguerre polynomials, Fourier series and simple applications, Laplace transforms and applications, convolution.

**Unit-IV**

The matrix Eigen value problems, Secular determinants, Characteristics polynomials, Eigen values and Eigen functions. Eigen values of real symmetric matrices; Eigen values and Eigen functions, important properties and examples.

**Unit-V**

Complex numbers, Analytic functions, Cauchy Riemann equations, Cauchy's integral formula, Residue theorem and simple applications.

**Books Recommended:**

S.No.	Author	Book
1	D.J.S. Robinson	A Course in Linear Algebra with Applications, World Scientific.
2	G. B. Thomas and R.L. Finney	Calculus and Analytic Geometry, 9th ed., Addison-Wesley/Narosa
3	J. Marsden, A. Tromba and A. Weinstein	Basic Multivariable Calculus, Springer
4	Inder K. Rana	Calculus@iitb, Concepts and Examples, Version 1.2

**CB 302: Biochemistry-I****Unit-I**

General biochemistry concepts: The concept of pH, dissociation and ionization of acids and bases, pKa, buffers and buffering mechanism, Henderson Hasselbalch equation, dissociation of amino acids and determination of pKa.

**Unit-II**

Chemical structure of Major: Carbohydrates, Lipids, Nucleic acids, Proteins: amino acid ; Chemical properties: molecular bond, covalent bond, ionic bond, hydrogen bond, ester, ; ethyl ; Molecular charge hydrophilic, hydrophobic, polar. pH : acid, alkaline, base. oxidation: reduction, hydrolysis Structural compounds:

In cells: flagellin, peptidoglycan, myelin, actin, myosin

In animals: chitin, keratin, collagen, silk

In plants: cellulose, lignin, cell wall

**Unit-III**

Enzymes and enzyme activity: enzyme kinetics , enzyme inhibition, proteolysis; ubiquitin – proteasome, kinase -- dehydrogenase

**Unit-IV**

Membranes : fluid mosaic model; diffusion, osmosis. Phospholipids, glycolipid, glycocalyx, antigen, isoprene ion channel; proton pump, electron transport , ion gradient, antiporter, symporter, quinone, riboflavin Lipids, Vitamins, Hormones

**Unit-V**

Protein structure and function: folding, modification, enzymes, enzyme kinetics, enzyme regulation and inhibition

**Books Recommended:**

S.No.	Author	Book
1	D. L. Nelson & M. M. Cox	Lehninger Principles of Biochemistry,
2	Stryer L (1995)	Biochemistry, 4 th edition,
3	Starzak, Michael E.	Energy and Entropy equilibrium to stationary states
4	J. McMurry (1999)	Fundamentals of General Organic & Biological Chemistry

**B 301: Cell Biology -I****Unit-I**

Cell biology - An Overview: Universal features of cells, Diversity of their genomes, Overview of cell chemistry (important atoms and their properties, pH, acids, bases, and buffers in cells, formation and functions of proteins, DNA, sugars, and fats in cells, Visualization of cell; Basic principles of light microscopy, Different microscopic techniques for imaging cells.

**Unit-II**

Membrane system: The cell membrane and its structure, Models of the biomembrane: Charles Overton's "Lipid Membrane", Lipid monolayer model of Irving Langmuir, Lipid bilayer model by Gorter and Grendel, Protein-containing lipid bilayer model of Davson and Danielli, David Roertson's direct observation of the membrane, Fluid Mosaic model of Singer and Nicholson, Constituents and fluidity of plasma membrane, Transport across membrane, Ion channels.



**Unit-III**

Cellular organelles and their functions: Mitochondria: Structure of mitochondria, Different enzymes and their location, Electron transport complexes, ATP synthase, Mitochondrial DNA, Structure of chloroplast, Protein complexes and photosynthetic electron transport chain, DNA of the chloroplast, Bioenergetics, Structure and functions of the ribosomes, Endoplasmic reticulum, Golgi body, Lysosomes, and Nucleus. Protein sorting, Vesicular traffic inside the cells, targeting & degradation

**Unit-IV**

Cytoskeleton, cilia and flagella: Structure and functions of Microtubules, Actin, and Intermediate filaments. Interplay between different cytoskeletal components. Molecular motors. Cilia and flagella: structure and functions. Diseases associated with the cytoskeleton, cilia, and flagella.

**Unit-V**

Organization, Replication, and Maintenance of the genome: Complexity of eukaryotic genomes, Chromosomes and chromatin, DNA replication, DNA damage and repair, DNA rearrangements

**Books Recommended:**

S.No.	Author	Book
1	D. L. Nelson & M. M. Cox	Lehninger Principles of Biochemistry,
2	Stryer L (1995)	Biochemistry,
3	Starzak, Michael E.	Energy and Entropy equilibrium to stationary states
4	J. McMurry (1999)	Fundamentals of General Organic and Biological Chemistry (Study Guide)

**CB 303: Organic Chemistry –I****Unit-I**

## A. Basic concepts - Recapitulation

Hybridisation, formal charge, inductive and resonance effects and their effect on reactivity and acidity and basicity of organic compounds; polar & non polar covalent bonds; homolytic and heterolytic fission, types of reagents- electrophiles and nucleophiles; curly arrow notation; classification of organic reactions.

**Unit -II**

## B. Chemistry of Aliphatic compounds

IUPAC nomenclature of aliphatic and substituted aliphatic compounds and alicyclic compounds

Preparation, structure, properties and reactions of the following classes of compounds.

Hydrocarbons - a) alkanes, Methods of formation Kolbe reaction, Wurtz reaction, Corey House reaction, decarboxylation of carboxylic acids; Mechanism of halogenation of alkanes, orientation, selectivity & reactivity, product ratio.

Cycloalkanes - Methods of formation and reactivity ; Baeyer's strain theory and its limitation; theory of strainless rings

Alkenes - Elimination reactions ; Saytzeff & Hoffman elimination; Reactions – halogenation reactions free radical and polar mechanisms. Markownikoff's rule, the peroxide effect, allylic halogenations using NBS; Ozonides/Ozonolysis. epoxidation; hydroboration-oxidation; oxymercuration-demercuration; Oxidation using KMnO<sub>4</sub> & OsO<sub>4</sub>.; polymerization.

Dienes - Structure of butadiene and allene ; 1,2 vs 1,4 addition ; Diels Alder reaction.

**Unit -III**

Alkynes - Methods of formation; acidity of alkynes; electrophilic addition to alkynes; hydroboration oxidation ; metal ammonia reductions; hydrogenation using Lindlar's catalyst.

Alkyl halides - Preparation, properties and synthetic applications of alkyl halides ; SN1 & SN2 reactions (mechanism), E1 and E2 reactions( mechanism); Grignard reagent and its applications.

Alcohols - Methods of formation ; acidity ; H-Bonding ; reactions of mono; di & trihydric alcohols;

Diols as protecting groups

**Unit -IV**

Ethers and epoxides - Formation & reactions of ethers and epoxides ; ring opening reactions of epoxides under acidic and basic conditions; reaction epoxides with Grignard & organolithium reagents  
Aldehydes & ketones - Methods of formation of aldehydes and ketones; Nucleophilic addition reactions with cyanide, ammonia and derivatives of ammonia; acetal formation; oxidation reduction reactions. Meerwin-Ponndorf-Verley reduction, Clemmensen reduction, Wolf-Kishner reduction, Aldol condensation reaction, Cannizzaro reaction, Tischenko reaction, haloform reaction, Baeyer-Villiger oxidation, Wittig reaction; Mannich reaction

**Unit -V**

Carboxylic acids - Methods of formation of mono and di carboxylic acids; acidity and factors affecting acidity; reactions of carboxylic acids :

Carboxylic acid derivatives - Methods of formation of acid chlorides, amides, anhydrides and esters and their interconversions; relative stabilities of acid derivatives; Rosenmund reaction; Hoffmann rearrangement; saponification.

Nitrogen and sulphur compounds - Nitro alkanes

**Books Recommended:**

S.No.	Author	Book
1	I. L. Finar	Organic Chemistry, Vol. 1 & 2, ELBS.
2	R. T. Morrison and R. N. Boyd	Organic Chemistry, Prentice Hall of India
3	L. G. Wade,	Organic Chemistry, Pearson Education
4	G. Solomons and C. Fryhle,	Organic Chemistry, John Wiley & Sons
5	W.G. Solomons	Fundamentals of Organic Chemistry,
6	J. March	Advanced Organic Chemistry, 3rd Edn.
7	F.J. Carey and R.J. Sundburg	Advanced Organic Chemistry, Part A & Part B
8	D. D. Ebbing	General Chemistry, Houghton Mifflin Co
9	M. J. Sienko and R. A. Plane	Chemical Principles and Applications,

**H 301: World Literature****Unit-I**

What is Literature? - a discussion; Introduction to literary terms, genres, and forms of various periods, countries, languages, etc. Comprehensive idea about Sanskrit literature in relation to scientific writing: Vedic and Classical literature

**Unit-II**

The Novel: Class study of 'Brave New World' by Aldous Huxley; Group discussions and student presentations on other genres such as the graphic novel, detective fiction, children's literature, etc.

**Unit-III**

Plays: Introduction to the history of theatre, class study of (mainly) two plays: 'Pygmalion' by G. B. Shaw and 'Fire and Rain' by Girish Karnad, the setting up of play –reading group through which the students can be introduced to several other plays.

**Unit-IV**

Poetry: Brief introduction; Study of poetic genres, forms, topics, figures of speech, poetic language etc. by analysing various poems from around the world

**Unit-V**

Short stories, essays and other types of writing by various authors. Screening of films based on literary works, such as Pygmalion (My Fair Lady), Fire and Rain (Agnivarsha), Persepolis (a graphic novel) and a few others.



### H302: History and Philosophy of Science

#### Unit-I

Brief overview of the contemporary cultural development elsewhere in the world; Indus Civilisation: progress of art, architecture, science and technology, role of geometry in art and architecture; Study of ancient Indian linguistic techniques and their relation with modern programming languages; Overview of Paninian style and techniques; Precision of Sanskrit in expressing technical terms; History of number naming and writing in India; Sulbasutra and Vedanga Jyotisha – geometrical constructions and astronomical calculations; Jain literature on mathematics and astronomy; Linguistic techniques used in Aryabhata; Works of Brahmagupta in opposition of Aryabhata; Contribution of Kerala school of mathematics to development of mathematical ideas.

#### Unit-II

Genesis of systematic ideas: Science in ancient Greece; against mythological explanations to natural phenomena; Early atomism, mathematical atomism, against atomism. Introduction to epistemology; Possible criteria of demarcation between science and folklore; Non-science and metaphysics; Introduction to logical positivism and the “standard view”; Criticism of “standard view”.

#### Unit-III

Method of analysis and synthesis; Beginning of mathematical sciences; multicultural origins of science. Renaissance and scientific revolution:

#### Unit-IV

Galilean ideas; mechanisation of world picture; From alchemy to chemistry, from natural history to evolutionary history, from natural numbers to complex numbers, from physiology to cell biology.

#### Unit-V

Rise of experimental science: Discussion of some of the crucial experiments with an emphasis on the analysis of conceptual changes rather than the technical details.

#### Books Recommended:

S.No.	Author	Book
1	Colin Ronan	Cambridge Illustrated History of Science
2	Rom Harre	Great Scientific Experiments: 20 Experiments that Changed our View of the World
3	T. A. Saraswati Amma	Geometry in Ancient and Medieval India
4	Kim Plofker	Mathematics in India (Princeton Univ. Press)
5	Samir Okasha	Philosophy of Science – A Very Short Introduction
6	Henry Collins and Trevor Pinch	The Golem – What Everyone should Know about Science by (Cambridge Uni. Press, 1996)
7	Alan Chalmers	What is this thing called Science?

### BL 301: Biology Laboratory (Biochemistry + Cell Biology)

- Biochemical calculation
- Amino acid titration:
  - Determine the pka value of the provided amino acid solutions using titration curve.
  - Identify the amino acids using the reference table on the basis of pka values obtained
- Carbohydrate identification & estimation by anthrone method
  - Extraction of carbohydrates from various sources.
  - Identification by dichotomous key & estimation by anthrone method
- Estimation of total free amino acids
  - Extraction of total free amino acids from plant sample estimation by ninhydrin reagent
- Acid value - Acid number is a measure of the amount of carboxylic acid groups a fatty acid
- Iodine number

- Iodine numbers are often used to determine the amount of unsaturation in fatty acids
7. Saponification value
    - Measure of the average molecular weight (or chain length) of all the fatty acids present
  8. Peroxide value - Gives the evidence of rancidity in unsaturated fats and oils
  9. Potato starch - isolation of starch
  10. Enzyme kinetics
    - Enzymatic reaction using potato starch and salivary amylase.
    - Determine Vmax and Km for individuals salivary amylase.
  11. pH and temperature effect on enzyme kinetics
    - Effect of pH and temperature on salivary amylase action on starch
  12. Effect of inhibitors on enzyme kinetics
  13. Carbohydrate identification by thin layer chromatography
    - Extraction of carbohydrates from various fruit sample and identification by separating using tlc
  14. Chromatography:
    - Paper chromatography, dimensional chromatography of a mixture of amino acids
    - Circular chromatography, Separation utilizing gel filtration and ion-exchange chromatography, S. Russo and A. Radcliffe, *J.Chem. Educ.* **68**, 168-171 (1991).
    - Isolation of lactoferrin by immobilized metal ion affinity chromatography (IMAC), A. Calvo and F. Batista-Viere, *Biochem. Educ.* **22**, 50-52 (1994).
    - Rapid microscale isolation and purification of yeast alcohol dehydrogenase using Cibacron blue affinity chromatography, C. Morgan and N. Moir, *J.Chem. Educ.* **73**, 1040-1041 (1996).
    - Chromatographic separation of two proteins, J. Szeberenyi, *Biochem. Mol. Biol. Educ.* **35**, 71-72 (2007).
  15. Electrophoresis
    - SDS-agarose gel electrophoresis in a simple procedure for determining high molecular weight protein oligomerization, M. Brownleader et al., *Biochem.Educ.* **22**, 155-158 (1994).
    - Capillary electrophoresis: a fast and simple method for the determination of the amino acid composition of proteins, P. Weber and D. Buck, *J. Chem. Educ.* **71**, 609-611 (1994).
    - Determination of the subunit molecular mass and composition of alcohol dehydrogenase by SDS-PAGE, B. Nash, *J. Chem. Educ.* **84**, 1508-1511 (2007).
    - Metal-catalyzed cleavage of tRNA-Phe, S. Kirk et al., *J. Chem. Educ.* **85**, 676-678 (2008).
    - Introducing proteomics in the undergraduate curriculum: A simple 2D gel electrophoresis exercise with serum proteins, T. Kim and P. Craig, *Biochem. Mol. Biol. Educ.* **38**, 29-34 (2010).
  16. Isolation and Characterization of Enzymes
    - Testing the  $\alpha$ -amylase inhibitor of the common bean, J. Moreno et al., *J. Chem. Educ.* **71**, 350-352 (1994). A rapid and inexpensive procedure for the determination of amylase activity, V. Mulimani and J. Lalitha, *Biochem. Educ.* **24**, 234-235 (1996).
    - A rapid and inexpensive procedure for the determination of proteolytic activity, S. Castro and A. Cantera, *Biochem. Educ.* **23**, 41-43 (1995).
    - Zymography of extracellular matrix proteases, A. Quesada et al., *Biochem. Educ.* **24**, 170-171 (1996).
    - The thermodynamic stability and catalytic activity of yeast alcohol dehydrogenase at different pH values, R. Tabor and J. Ladwig, *Biochem. Educ.* **25**, 169-170 (1997).
    - The competitive inhibition of yeast alcohol dehydrogenase by 2,2,2-trifluoroethanol, R. Tabor, *Biochem. Educ.* **26**, 239-242 (1998).
    - From egg to crystal: a practical on purification, characterization, and crystallization of lysozyme for bachelor students, V. Olieric et al. *Biochem. Mol. Biol. Educ.* **35**, 280-286 (2007).
    - Lactate dehydrogenase kinetics and inhibition using a microplate reader, J. Powers et al. *Biochem. Mol. Biol. Educ.* **35**, 287-292 (2007).
  17. Cell biology
    - Cell staining – i (capsule, cell wall, lipid granules)
    - Cell staining – ii (metachromatic granules, endospores)
    - Cell motility
    - Subcellular fractionation of mouse liver tissue, page & wester blotting
    - Immunoflourescence of cytoskeleton & nuclear proteins
    - Meiosis using lily anthers



## GL 301- Applied Electronics Lab

### Experiments based on:

- 1- Norton's theorem and Maximum power transfer theorem; basic concepts of semiconductor diode and transistor;
- 2- Principle of DC power supply; half and full wave bridge rectifier, capacitor filter – ripple factor,
- 3- Zener regulator; concept of Switch Mode Power Supply (SMPS), power supply ICs,
- 4- Bipolar Junction Transistor (BJT) – biasing circuits:
- 5- Analog to Digital Converter (ADC); filters: low pass, high pass; band pass; Butterworth filter
- 6- controlled inverter, adder / subtracter, parity checker; Flip-Flops (FF):
- 7- RS-FF, D-FF, JK-FF; counters and shift registers: binary counter, ripple counter.

## Semester – IV [January - June 2017]

### B401: Cell Biology - II

#### Unit-I

Cell Junctions, Cell Adhesion, and the Extracellular Matrix: Introduction, Cell Junctions, Cell-Cell Adhesion, The Extracellular Matrix of Animals, Extracellular Matrix Receptors on Animal Cells. Integrins, Selectins, and other proteins involved in intercellular contacts. The Plant Cell Wall

#### Unit-II

Cell signaling: 1. Introduction: Components involved in signaling, Types of signaling, Three Major Classes of Signaling Receptors: Ion Channel-linked, G protein-coupled receptors (GPRs), Enzyme-linked receptors: Tyrosine-Kinase Receptors, other enzyme-linked receptors, Second Messengers: cAMP, cGMP, IP3 and DAG, Ca<sup>2+</sup>, PIP3. Signaling Cascades. Cell signaling and cancer.

#### Unit-III

Cell cycle and Cell division: Mechanisms and regulations of cell division, Mitosis, Meiosis, and Germ cells, Cell renewal, Uncontrolled cell division and cancer.

#### Unit-IV

Types of cell death: Apoptosis, Necrosis, Anoikis, Oncosis

#### Unit-V

Techniques in Cell biology: Cell fractionation, DNA libraries, DNA transfer into eukaryotic cells and Mammalian embryos, Nucleic acid hybridization, Purification of nucleic acid, Isolation and fractionation of proteins.

### Books Recommended:

S.No.	Author	Book
1	Alberts <i>et al.</i>	Molecular biology of the Cell
2	Alberts, Bray <i>et al</i>	Essential Cell Biology Garland, Publication New York 1997
3	James E. Darnell, Harvey F. Lodish, and David Baltimore	Molecular Cell Biology
4	Geoffrey M Cooper	The Cell, 2nd edition, A Molecular Approach
5	<a href="http://publications.nigms.nih.gov/inside-the-cell/index.html">http://publications.nigms.nih.gov/inside-the-cell/index.html</a>	Inside the Cell, an internet-based study of cells (National Institute of General Medical Sciences)

**B 402: Biochemistry-II****Unit-I**

Metabolism and metabolic pathways: Glycolysis, TCA cycle, Oxidative Phosphorylation, Photophosphorylation

**Unit-II**

Biosynthesis of macromolecules: Carbohydrate biosynthesis (Pentose phosphate pathway), Fatty acid synthesis, Cholesterol of steroid biogenesis, Amino acid biosynthesis & degradation, Nucleotide biosynthesis & degradation, Fatty acid degradation

**Unit-III**

Pigments : chlorophyll , carotenoids, xanthophyll , cytochrome, phycobilin, Bacteriorhodopsin, hemoglobin, myoglobin, absorption spectrum, action spectrum, fluorescence

**Unit-IV**

Photosynthesis : light reaction -- dark reaction. Fermentation : Acetyl-CoA -- lactic acid  
Cellular respiration : Adenosine triphosphate (ATP) - NADH - pyruvate - oxalate – citrate Chemosynthesis

**Unit-V**

Regulation hormones : auxin signal transduction -- growth factor -- transcription factor -- protein kinase -- SH3 domain Malfunctions : tumor -- oncogene -- tumor suppressor gene Receptors : Integrin -- transmembrane receptor -- ion channel

**Books Recommended:**

S.No.	Author	Book
1	D. L. Nelson , M. Cox	Lehninger Principles of Biochemistry,
2	Stryer L	Biochemistry.
3	Starzak Michael E.	Energy and Entropy equilibrium to stationary states
4	J McMurry	Fundamentals of General Organic and Biological Chemistry (Study Guide)

**CB 401: Introductory Spectroscopy [UV-Vis, Florescence, IR, Raman, NMR]****Unit-I**

The electromagnetic spectrum: Nature of electromagnetic radiation. The electromagnetic spectrum and its regions. Frequency, waveno and wavelength: units and conversions. Absorption of electromagnetic radiation. Molecular energy states and quantisation of internal energy. Boltzmann distribution. Spectroscopic Processes: Absorption, emission, and scattering of light. Beer-Lambert Law - Quantitative absorption measurements, Jablonski diagram Fourier transformation: A mathematical tool to our advantage, basic principle and its relevance in spectroscopy.

**Unit -II**

UV-VIS Absorption Spectroscopy: Principles and instrumentation of spectrophotometers. UV-vis spectroscopy to determine conjugation. UV-visible spectroscopy and electronic transitions. Electronic ground states and excited states in organic molecules: pi-star and pi to pi-star transitions. band position and band intensities. Fluorescence Spectroscopy: Principles and instrumentation of fluorimeters. Advantage of fluorimetry compared to absorption spectrophotometry. Luminescence and the fate of excited states: timescale of fluorescence and phosphorescence. Qualitative and Quantitative Fluorimetry.

**Unit -III**

IR - Principles and instrumentation of Infrared spectroscopy. nfrared spectroscopy and molecular vibrational transitions. Simple dispersive IR spectrometer and overview of modern instrumentation. Transmittance and absorbance. Vibrational modes and selection rules. Factors governing the position and intensity of IR bands: effects of variation in reduced mass and force constant. Group frequency and fingerprint regions: use of IR for identification by presence/absence of absorptions characteristic of specific bonds/bond groupings.



Interpretation of IR spectra.

Raman Spectroscopy: Raman Effect and molecular polarizability. Technique and instrumentation. Pure rotational Raman spectra, vibrational Raman spectra. Structure determination from Raman and IR.

#### Unit -IV

Nuclear Magnetic Resonance (NMR): Introduction to Nuclear Magnetic Resonance (NMR) spectroscopy. number of signals, integration, chemical shift, splitting of signals. Principles and instrumentation of NMR spectroscopy. Nuclear spin and nuclear magnetism. Energies of nuclear spin states in a magnetic field. Boltzmann population of nuclear spin states and the origin of NMR signals.. Information from: chemical shifts and delta values, peak areas and integration, splitting patterns and spin-spin coupling constants. (n+1) rule and Pascal's triangle. Interpretation of NMR spectra using

#### Unit -V

Examples of organic compounds. Short introduction about application of NMR for proteins.

Mass spectrometry: Introduction to mass spectrometry (molecular mass, accurate mass and isotopes) Principles, ionisation methods (including EI, MALDI, ESI). Molecular ions and fragmentation processes under EI. Mass spectrometry for determining the molecular weight/formula of organic compounds and identify the presence of isotopes. Introduction of MS application in protein analysis.

#### Books Recommended:

S.No.	Author	Book
1	K Wilson and John Walker	Practical Biochemistry: Principles & Techniques
2	GR Chatwal and SK Anand	Instrumental methods of Chemical Analysis
3	S. K. Sawhney	Introductory Practical Biochemistry
4	RF Boyer	Biochemistry Laboratory: Modern Theory & Techniques
5	S Carson, H Miller and D Scott	Molecular Biology Techniques: A Classroom Laboratory Manual
6	T C Ford and J M Graham	An Introduction to Centrifugation
7	TS Work and E Work	Density Gradient Centrifugation, Vol. 6
8	David Rickwood	Centrifugation Techniques
9	A Braithwaite and FG Smith	Chromatographic Methods
10	LR Snyder, JJ Kirkland & JW Dolan	Introduction to Modern Liquid Chromatography
11	S J Pennycook and PD Nellist	Scanning Transmission Electron Microscopy
12	DJ Rawlins	Light microscopy
13	M Hoppert	Microscopic Techniques in Biotechnology
14	M Hoppert and A Holzenburg	Electron microscopy in microbiology
15	T Peng, D L Horrocks and E L Alpen	Liquid Scintillation Counting: Recent Applications and Development, Volume I
16	R Baserga and D Malamud	Autoradiography: techniques and application
17	T Chard	An Introduction to Radioimmunoassay and Related Techniques , Volume 6
18	MD Bruch	NMR Spectroscopy Techniques
19	B A Wallace and R. William	Modern Techniques for Circular Dichroism and Synchrotron Radiation ..., Volume 1

## PCB 401: Physical & Chemical Kinetics

### Unit -I

Basic Concepts: Rate, order and molecularity of a reaction, First, second and third order reactions – effect of concentration on reaction rate, rate expressions and integrated form, pseudo-unimolecular and second order autocatalytic reactions, nth order reaction of a single component, effect of temperature on reaction rate – Arrhenius equation and activation energy.

Complex Reactions: parallel first order reactions, series first order reactions – determination of rate constants by graphical method and the time ratio method. The stationary state, radioactive decay, general first order series and parallel reactions. Competitive, consecutive second order reactions, reversible reactions, equilibrium from the kinetic view point, complex mechanisms involving equilibria.

### Unit -II

Kinetic Measurements: Experimental determination of reaction rates and order of reactions –correlation of physical properties with concentrations, reactions in the phase, reactions at constant pressure, fractional-life period method, initial rate as a function of initial concentrations.

Reactions in Solutions: General Properties, Phenomenological theory of reaction rates, Diffusion limited rate constant, Slow reactions, Effect of ionic strength on reactions between ions, Linear free energy relationships, Relaxation methods for fast reactions.

### Unit -III

Catalysis: Homogeneous catalysis in gas phase, in solution, basis of catalytic action, catalysis and the equilibrium constant, acid base catalysis, The Bronsted catalysis law, linear free energy changes, general and specific catalysis. Heterogeneous catalysis. Negative catalysis and inhibition, Surface reactions – effect of temperature and nature of surface. Industrial catalysis.

Chain reactions: general treatment, activation energy, chain length, chain transfer reactions, inhibition.

### Unit -4

Bond dissociation energies, branching chain reactions.

The collision theory: Dynamics of bimolecular collisions and rate and rate constant of bimolecular reaction, factors determining effectiveness of collisions, Termolecular reactions, unimolecular reactions. Relation between cross section and rate coefficients.

Potential Energy Surfaces: Long range, empirical intermolecular and molecular binding potentials, Internal coordinates and normal modes of vibration, Potential energy surfaces, ab-initio calculation of potential energy surface, experimental determination of potential energy surfaces, Details of the reactionpath, potential energy surface for electronically excited molecule. Molecular beam scattering, Stateresolved spectroscopic technique, molecular dynamics of H<sub>2</sub> + H reaction, state-to-state kinetics of F +H<sub>2</sub> reaction.

### Unit -V

Transition State Theory (TST): Motion on the potential energy surface, Basic postulates and derivation of TST, dynamical derivation of TST, Quantum mechanical effects on TST, Thermodynamic formulation of TST, Application of TST, Microcanonical TST, Variational TST, Experimental observation of TST.

### Books Recommended:

S.No.	Author	Book
1	K.A. Connors	Chemical Kinetics: A Study of Reaction Rates in Solution,
2	J.I. Steinfeld, J.S. Francisco & W.L. Hase	Chemical Kinetics and Dynamics,
3	K. J. Laidler	Chemical Kinetics,
4	R. D. Levine and R. B. Bernstein	Molecular Reaction Dynamics & Chemical Reactivity
5	J.W. Moore and R.G. Pearson	Pearson, Kinetics and Mechanisms,
6	Sanjay K. Upadhyay	Chemical kinetics and Reaction Dynamics,



## G 401: Statistical Techniques and Applications

### Unit-I

Purpose of Statistics, Events and Probabilities, Assignments of probabilities to events, Random events and variables, Probability Axioms and Theorems. Probability distributions and properties: Discrete, Continuous and Empirical distributions.

### Unit-II

Expected values: Mean, Variance, Skewness, Kurtosis, Moments and Characteristics Functions. Types of probability distributions: Binomial, Poisson, Normal, Gamma, Exponential, Chi-squared, Log-Normal, Student's t, F distributions, Central Limit Theorem

### Unit-III

Monte Carlo techniques: Methods of generating statistical distributions: Pseudorandom numbers from computers and from probability distributions, Applications. Parameter inference: Given prior discrete hypotheses and continuous parameters, Maximum likelihood method for parameter inference.

### Unit-IV

Error Analysis: Statistical and Systematic Errors, Reporting and using uncertainties, Propagation of errors, Statistical analysis of random uncertainties, Averaging Correlated/ Uncorrelated Measurements. Deconvolution methods, Deconvolution of histograms, binning-free methods. Least-squares fitting: Linear, Polynomial, arbitrary functions: with descriptions of specific methods; Fitting composite curves.

### Unit-V

Hypothesis tests: Single and composite hypothesis, Goodness of fit tests, P-values, Chi-squared test, Likelihood Ratio, Kolmogorov-Smirnov test, Confidence Interval. Covariance and Correlation, Analysis of Variance and Covariance. Illustration of statistical techniques through hands-on use of computer programs.

### Books Recommended:

S.No.	Author	Book
1	R.J. Barlow	Statistics: A Guide to the Use of Statistical Methods in the Physical Sciences
2	John Mandel, Dover	The Statistical Analysis of Experimental Data
3	Philip Bevington and Keith Robinson	Data Reduction and Error Analysis for the Physical Sciences, 3rd Edition

## BL401: Biology Laboratory (Biochemistry + Cell Biology)

### 1. Ligand Binding

- a) The binding of coomassie brilliant blue to bovine serum albumin, J. Sohl and A. Splittgerber, *J. Chem. Educ.* **68**, 262-264 (1991).
- b) Evaluation of the Hill coefficient from Scatchard and Klotz plots, A. Sabouri and A. Moosavi-Movahedi, *Biochem. Educ.* **22**, 48-49 (1994).
- c) The shapes of Scatchard plots for systems with two sets of binding sites, A. Bordbar et al., *Biochem. Educ.* **24**, 172-175 (1996).

### 2. Spectroscopy

- d) Fluorescence quenching of albumin. A spectrofluorimetric experiment, M. Montero et al, *Biochem Educ.* **18**, 99-101 (1990).
- e) Lactate dehydrogenase kinetics and inhibition using a microplate reader, J. Powers et al., *Biochem. Mol. Biol. Educ.* **35**, 287-292 (2007).

### 3. Isolation and Analysis of Biomolecules - Amino acids/peptides/proteins/antibodies

- f) Application of gel filtration for fractionation and molecular weight determination of proteins, O. Malhotra and A. Kumar, *Biochem. Educ.* **17**, 148-150 (1989).

g) Protein structure and chromatographic behavior: The separation and characterization of four proteins using gel filtration and ion-exchange chromatography and gel electrophoresis, M. Chakravarthy, L. Snyder, T. Vanyo, J. Holbrook, and H. Jakubowski, *J. Chem. Educ.* **73**, 268-272 (1996).

#### 4. Isolation and Analysis of Biomolecules - Carbohydrates

- h) Changes in carbohydrate content during fruit ripening—a new approach of teaching carbohydrate chemistry in biochemistry course, P. Chaimanee and O. Suntornwat, *Biochem. Educ.* **22**, 101-102 (1994).  
 i) Carbohydrate Analysis: Can we control the ripening of bananas?, S. Deal, C. Farmer, and P. Cerpovicz, *J. Chem. Educ.* **79**, 479-480 (2002).

#### 5. Isolation and Analysis of Biomolecules - Lipids

- j) Isolation and spectrophotometric characterization of photosynthetic pigments, R. Boyer, *Biochem. Educ.* **18**, 203-206 (1990), and *Modern Experimental Biochemistry*, 3rd ed., p. 333-344, (2000) Benjamin Cummings. (San Francisco).  
 k) An improved method for the extraction and thin-layer chromatography of chlorophyll a and b from spinach. H. Quach, R. Steeper, and G. Griffin, *J. Chem. Educ.* **81**, 385-387 (2004).

#### 6. Metabolism/Regulation/Transport

- l) The energetics of aerobic versus anaerobic respiration, T. Champion and R. Schwenz, *J. Chem. Educ.* **67**, 528-530 (1990).  
 m) Use of DCPIP in a colorimetric method to investigate electron transport in crude heart mitochondrial extracts, A. Myers, *Journal of Biol. Educ.* **24**, 123-126 (1990).  
 n) Mitochondria from rat liver: method for rapid preparation and study, C. Heisler, *Biochem. Educ.* **19**, 35-38 (1991).  
 o) An experiment on glycogen biosynthesis in *E. coli*, A. Lodeiro et al, *Biochem. Educ.* **22**, 213-214 (1994).  
 p) An experiment illustrating catabolite repression in yeast, W. Baker, *Biochem Educ.* **23**, 216-217 (1995).  
 q) A simple experiment demonstrating the allosteric regulation of yeast pyruvate kinase, R. Taber, A. Campbell, and S. Spencer, *Biochem. Educ.* **26**, 73-76 (1998).  
 r) A simple laboratory exercise illustrating active transport in yeast cells, B. Stambuk, *Biochem. Mol. Biol. Educ.* **28**, 313-317 (2000).  
 s) The pentose phosphate pathway in the yeasts *Saccharomyces cerevisiae* and *Kloeckera apiculata*, an exercise in comparative metabolism for food and wine science students, C. Steel, P. Grbin, and A. Nichol, *Biochem. Mol. Biol. Educ.* **29**, 245-249 (2001).  
 t) Kinetic analysis of glucose-6-phosphatase: an investigative approach to carbohydrate metabolism, M. Wallert, J. Foster, D. Scholnick, A. Olmschenk, B. Kuehn, and J. Provost, *Biochem. Mol. Biol. Educ.* **29**, 199-203 (2001).  
 u) Nitrate reductase: A model system for the investigation of enzyme induction in eukaryotes, C. Pike, W. Cohen, and J. Monroe, *Biochem. Mol. Biol. Educ.* **30**, 111-116 (2002).

#### CELL BIOLOGY

- v) Programmed Cell Death DNA Laddering and Cell death assay (quantification by Evans Blue)  
 w) Post-translational modification of proteins  
 x) Introducing undergraduate students to real-time PCR, D. Hancock et al., *Biochem. Mol. Biol. Educ.* **38**, 309-316 (2010).  
 y) *Caenorhabditis elegans* as an undergraduate educational tool for teaching RNAi, J. Andersen et al., *Biochem. Mol. Biol. Educ.* **36**, 417-427 (2008).

### GL 401: Computational Laboratory and Numerical Methods

This course is primarily a lab course introducing computational techniques used for solving mathematics problems numerically. Vast amount of software for solving these problems exists and has been put together in general purpose packages such as MATHEMATICA, MAXIMA, MAPLE and so on.

Computing special functions (using recurrence relations, Attn: loss of accuracy and its effects), making subroutines/functions for these. Computing derivatives numerically (accuracy issues). Zeros (roots) of functions (single variable, multivariable, complex functions poles as zeros of inverse function). Solving differential equations (single variable, any order), Euler and Runge-Kutta, initial and boundary value problems. Eigenvalue problems as boundary value problems.



Numerical integration: trapezoidal and Simpson rules, Gaussian quadrature rules. Linear equations, inverse of a matrix, determinant using Gauss elimination. Matrix eigenvalue problems, Euler rotations, relaxation methods. Data fitting,  $\chi$  methods, some simulations minimization. Random number generators, Monte-Carlo methods, some simulations.

### Third Year

#### Semester – V [ July - December 2017]

#### B501: Genetics

##### Unit-I

Introduction and overview of genetics: Information transfer DNA-RNA-Protein/genotype & phenotype, Eukaryotic & Prokaryotic genes, Pseudogenes. Gene regulation:  $\lambda$  phage, Bacterial gene regulation, Eukaryotic gene regulation, Epigenesis, Reverse genetics, genomes and genomics.

##### Unit-II

Mendelian inheritance (in details): *basics would have been taught*, Cell division- mitosis & meiosis (*revise: would have been taught*), Deviation from mendelian inheritance, Linkage & Sex-linked inheritance Model genetic systems.

##### Unit-III

Human genome and genetics: Elements of human genetics & genetic disorders, Examples from *Drosophila*, yeast, maize and mouse, Immunogenetics.

##### Unit-IV

Genes and Evolution: The law of DNA constancy and C-value paradox: Numerical and structural changes in chromosomes; Molecular basis of spontaneous and induced mutations and their role in evolution; Environmental mutagenesis and toxicity testing; Population genetics.

##### Unit-V

Biostatistics: Principles and practice of statistical methods in biological research; samples and populations; Basic statistics – average, statistics of dispersion, coefficient of variation; Standard error; Confidence limits; Probability distributions binomial, Poisson and normal; Tests of statistical significance; Simple correlation of regression; Analysis of variance, Population genetics.

#### Books Recommended:

S.No.	Author	Book
1	E. J. Gardner, D.P Snustad and M. J. Simmons	Principles of Genetics
2	Leland Hartwell, Leroy Hood, Michael Goldberg, Ann Reynolds, Lee Silver, Ruth Veres.	Genetics: From genes to genomes
3	Anthony J. F. Griffiths. 2010	Introduction to genetic analysis
4	Harvey Motulsky, 2010	Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking
5	Marcello Pagano, 2000	Principles of Biostatistics
6	Genetics for Dummies, 2005	T. R. Robinson

## B 502: Molecular Biology

### Unit-I

Molecular biology an overview: Concept and definition of the gene, complexity of the eukaryotic gene. Structural organization of the DNA in the nuclear material- General properties of histones, nucleosomes and solenoid structure, RNAs and their structure & function.

### Unit-II

DNA synthesis: The enzymes of DNA replication in prokaryotes and eukaryotes, mechanism of replication in bacteria and viruses, reverse transcriptase, salient features of eukaryotic nuclear and mitochondrial DNA replication.

RNA synthesis: The enzymes of transcription in prokaryotes and eukaryotes, mechanism of transcription in bacteria, heteronuclear RNA, post transcriptional processing of RNA, role of ribozymes.

### Unit-III

Protein synthesis: Concept of the genetic code, structure of t-RNA and t-RNA, enzymes of translation in prokaryotes and eukaryotes, mechanism of protein synthesis, post translational processing of proteins.

### Unit-IV

Gene expression and its characterization: Regulation of gene expression in prokaryotes and eukaryotes, structure and mechanism of different operons, Gene regulation during development, Gene function and phenotype loss of function & gain of function, Gene interaction, suppressors & enhancers redundancy & epistasis.

### Unit-V

Mutations and their consequences: Definition of mutation, mutagenesis & mutant selection, Alleles, Complementation, Recombination, recombination mapping and mechanism of recombination, Repair of DNA, Transposons & retroposons, Genomic & evolution of diversity.

### Books Recommended:

S.No.	Author	Book
1	Stryer L	Biochemistry, 4 th edition,
2	Watson J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A. and Weiner, A. M.	Molecular biology of the gene, 4 <sup>th</sup> edition, The Benjamin/Cummings publishing companies,
3	Benjamin Lewin	Genes VII, oxford University Press, Oxford
4	Weaver R. F.	Molecular biology,
5	Brown T A	Essential molecular biology, vol. I, A practical approach, IRL press, Oxford.28
6	Cox Lynne S	Molecular Themes in DNA Replication
7	Cantor, C. R., and Schimmel, P. R.	Biophysical Chemistry.

## B 503: Biodiversity of plants/animals/microbes

### Unit-I

Principles of taxonomy: Concept of species and hierarchical taxa, Biological nomenclature, Taxonomical structure, Outline classification of animals, important criteria used for classification in each Taxon., Classification of animals Levels of Structural organizations: Larval forms and their evolutionary significance, Unicellular, colonial, and multicellular forms, Levels of organization of tissues, organs, and systems, Comparative anatomy

### Unit-II

Classical and quantitative methods in taxonomy: Biosystematics, Interrelationship among major invertebrate phyla and minor invertebrate phyla; Evolutionary relationship among taxa, Natural History of



Indian subcontinent: Major habitat types, Geographical origin and migration of species , Common Indian mammals and birds, Seasonality and Phenology of Indian subcontinent

Deriving Solutions: Examine the concepts, benefits, and limitations of the different strategies for conserving biodiversity. a. Conservation Strategies, b. Laws and Legal Actions, c. Grassroots Action Program

### Unit-III

Taxonomy of plants: Plant identification, nomenclature, collecting and documentation, plant phylogeny and systematics.

Comparative anatomy and morphology of angiosperms and gymnosperms. Angiosperms:

Characteristic features, outline classification, vascular anatomy, leaves, flower, fruits and seeds.

Gymnosperms: Characteristic features, outline classification, morphology and anatomy of ovules and female gametophyte, microspore and male gametophyte, seeds, stem and leaves.

### Unit-IV

Concepts and characteristics of biodiversity: The concepts of biodiversity, Comparison of historical and current rate of species extinction, How genetic diversity may change between generations and within population of species, Complexity and functions of ecosystems; predictable and non-predictable features of ecosystem, Importance of preserving biodiversity, Genetic diversity

### Unit-V

Causes and consequences of biodiversity loss: Address the major threats to biodiversity. The biggest threat is from habitat loss and alteration followed by the introduction of exotic species that become invasive. Chemical alteration of the environment also has a major impact on both natural and managed ecosystems.

a. Habitat Loss & Alteration b. Exotic Species c. Chemical Pollutants d. Loss of Genetic Diversity in Crops

### Books Recommended:

S.No.	Author	Book
1	Cecie Starr, Ralph Taggart, Christine Evers, and Lisa Starr	Biology: The Unity and Diversity of Life
2	Hawksworth, D. L. & Bull Alan T.	Plant Conservation and Biodiversity. Series: Topics in Biodiversity and Conservation, Vol. 6 (Eds.) Reprinted from Biodiversity and Conservation, 16:6, 2007, VIII, 424 p.
3	M P Singh	Plant Biodiversity & Taxonomy
4	E.O.Wilson, <i>Editor</i> . Frances M. Peter	Biodiversity
5	Peter H. Raven, Ray F. Evert, and Susan E. Eichhorn	Biology of Plants

## CB 501- Analytical Chemistry

### Unit-I

Statistics in chemical analysis: Methods of sampling and associated errors, Classification of errors, Propagation of errors, treatment of errors, Normal distribution, Tests of Significance and Confidence Limits.

### Unit -II

Separation techniques:

a. Solvent Extraction Technique: Conventional, Liquid Membranes – Bulk, Supported and Emulsified, Solid Phase Extraction (SPE).

b. Ion Exchange: Conventional, Membranes.

c. Chromatography: Gas chromatography (GC), High Performance Liquid Chromatography ( HPLC), Ion chromatography ( IC).

**Unit -III**

Mass Spectrometry: Mass Analysers – Magnetic, Quadrupole, Time of Flight (TOF), Ion Cyclotron Resonance, Features – Resolution, Dispersion, Abundance, Sensitivity , Detectors – Faraday Cup, Channeltron, Daly, Ion Sources –Thermal Ionisation (TI), Electron Impact, ICP, GD, Laser Ablation (LAICP), Secondary Ionisation (SI), Resonance Ionisation (RI), Matrix Assisted Laser Desorption and Ionisation (MALDI), Hyphenated Technique – IC-MS, HPLC-MS, GC-MS.

**Unit -IV**

Thermal Methods: Thermogravimetric Analysis (TGA), Derivative Thermogravimetric Analysis (DTG), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Evolved Gas Analysis (EGA).

**Unit -V**

Electrochemical Methods: Introduction, Potentiometry , Ion Selective Electrodes (ISE), Voltammetry & Polarography , Cyclic, Pulse and Stripping Voltammetry, Coulometry and Amperometry, AC Electrochemical Techniques, Scanning Electrochemical Microscopy.

**Books Recommended:**

S.No.	Author	Book
1	RA Meyers	Encyclopaedia of Analytical Chemistry: Applications, Theory and Instrumentation
2	DA Skoog, DM West, FJ Holler and SR Crouch	Fundamentals of Analytical Chemistry, 8 <sup>th</sup> Edition
3	DA Skoog, FJ Holler and TA Niemann	Principles of Instrumental Analysis, 5 <sup>th</sup> Edition, Saunders College Publishing (1998)
4	GH Jeffery, J Bassett, Mendham and RC Denney	A text book of Quantitative Analysis, 5th Edition Revised
5	AK De and SM Khopkar	Chalmers, Solvent Extraction of Metals, Van Nostrand, Reinhold
6	F Helfferich	Ion Exchangers, McGraw Hill
7	LR Snyder and JJ Kirkland	Introduction to Modern Liquid Chromatography, 2nd Edition, Wiley
8	Editors JA Marinsky, Y Marcus, Marcel Dekker	Ion Exchange and Solvent Extraction: A Series of Advances
9	ED Katz Chichester	High Performance Liquid Chromatography : Principles and Methods in Biotechnology;
10	A Metcalfe	Atomic Absorption and Emission Spectroscopy,
11	K Jose and AC Broekaert	Analytical Atomic Spectrometry with flames and Plasmas, Wiley-VCH
12	IJ Sneddon	Advances in Atomic Spectroscopy, Jai Press
13	M John Roboz	Introduction to Mass Spectrometry: Instrumentation and Techniques, Interscience
14	Steve J Hill	Inductively Coupled Plasma Spectrometry and its Application, Sheffield Academic Press
15	WW Wendlandt	Thermal Methods of Analysis, 2nd Edition, Wiley
16	T Daniels, Kogan Page	Thermal Analysis
17	AJ Bard and LR Faulkner	Electrochemical Methods, 2nd Edition, Wiley
18	SP Kruger	Principles of Activation Analysis, Wiley Interscience
19	LC Feldman and JW Meyer	Fundamentals of Surface and Thin Film Analysis, North Holland
20	JC Miller and JN Miller	Statistics for Analytical Chemistry, 2nd Edition, Wiley



## G 501: Earth Science and Energy & Environmental Sciences

### Unit –I

Origin of the earth, type of rocks in different layers, their physical and chemical properties. Mechanism of their formation and destruction. Radioactivity and its role in geochronology, Plate tectonics and geodynamics and the role of mantle plumes in sustaining these processes. Gravity, electrical, seismic and magnetic properties of the different layers in the earth. Their variations in different geological terrains. Instrumentation, field procedures used in these studies. Response of the earth to the elastic (Seismic) and electromagnetic waves, use of this phenomena to study the earth's interior.

### Unit-II

Geodynamo and the internal magnetic field of the earth. Paleomagnetic studies, Polar wandering and reversal, possible theoretical arguments for understanding the phenomena. Seismology and its use in understanding of the different layers in the earth's interior. Utility of the different geophysical techniques (discussed above) in exploration for academic as well as for harnessing resources.

### Unit-III

Introduction to Environmental Science. Natural Environments: Ecosystems and ecology, biodiversity. Socio-cultural environments: demography, population density, human organizations. Land use and its planning. Global climate change and effects on environment. Carbon cycle from human activity, calculation of carbon budgets.

### Unit-IV

Water harvesting, storage and treatment. Natural calamities, hazards, and effects of human activity: Chemical and other technological hazards. Introduction to energy Sources - evolution of energy sources with time. Power production, per capita consumption in the world, and relation to development index. Energy scenario in India: Various issues related to consumption and demands -energy crisis issues in India. Renewable and non-renewable energy sources - technology and commercialization of energy sources, local (decentralized) versus centralized energy production, constraints and opportunities of renewable energy (hydrocarbon and coal based energy sources).

### Unit-V

Energy conservation – calculation of energy requirements for typical and home and industrial applications. Alternative to fossil fuels - solar, wind, tidal, geothermal. Bio-based fuels. Hydrogen as a fuel. Energy transport and storages, comparison of energy sources - passage from source to delivery (source, production, transport, delivery) - efficiencies, losses and wastes. Nuclear energy: Power production: Components of a reactor and its working, types of reactors and comparison. India's three stage nuclear program. Nuclear fuel cycle. Thorium based reactors. Regulations on nuclear energy.

### Books Recommended:

S.No.	Author	Book
1	Merill RT, McElhinny MW and McFadden PL	The magnetic field of the Earth: International Geophysical Series
2	Edward J, Tarbuck EJ and Lutgens FK	Earth Science
3	HR Sheehan <i>et al.</i> ,	Introduction to Applied Geophysics: Exploring the Shallow Subsurface Burger
4	Condie KC	Mantle Plumes and Their Record in Earth History; Cambridge University Press, Cambridge, UK

5	WM Telford, Robert E Sheriff and LP Geldart	Applied Geophysics (Paperback)
6	JB Marion	Energy in Perspective, University of Maryland, Academic Press
7	Robert A Ristinen and Jack J Kraushaar	Energy and Environment, , 2nd Edn., John Wiley and Sons, Inc.
8	Boyle Godfrey	Renewable Energy, Oxford University Press
9	D.K.Asthana and Meera Asthana	Environment, Problems and Solutions, S. Chand and Company
10	Balaram Pani IK	Text Book on Environmental Chemistry, International Publishing House

### BL 501: Biology Laboratory (Molecular Biology + Biodiversity + Genetics)

#### 1. BACTERIAL GENETICS

- a) *E. coli* Transformation
- b) *E. coli* Conjugation
- c) *E. coli* Transduction
- d) Phage Titration
- e) Transposition
- f)  $\alpha$ - Complementation

#### 2. EUKARYOTIC GENETICS

- g) To Study the model organism, *Drosophila Melanogaster*
- h) Concept of Crossing: - Monohybrid and Dihybrid crosses using *Drosophila Melanogaster*
- i) *Drosophila* Genetics:  
To Observe & Study the Mutants of *Drosophila Melanogaster*  
Concept of Mutation - Lethal Mutations
- j) Karyotyping

#### 3. BIODIVERSITY

- k) Setting up biodiversity niches in the lab & Hospital :fish-tank & Winogradsky column
- l) Biodiversity in soil, air & Winogradsky's Column – Plating , Colony Characterization & Gram Staining
- m) Field Trips - SEWRI MUD FLATS – ½ DAY, COLABA WOODS - ½ DAY, THANE BUTTERFLY PARK - ½ DAY, KARNALA BIRD SANCTUARY - ½ DAY, MAHIM NATURE PARK - ½ DAY

#### 4. MOLECULAR BIOLOGY

- n) General Laboratory Procedures  
Pouring Nutrient Agar Plates; Preparation of Solutions;  
Bacterial Culturing Techniques
- o) Designing of Primers for PCR procedure
- p) Extraction and Isolation of genomic DNA Using Kit method  
By conventional Ethanol Precipitation method
- q) Detection of Nucleic acids (AGE)
- r) Polymerase Chain Reaction (PCR) & Detection of the PCR product and its purification
- s) Blunt-end cloning (after Ligation)
- t) Preparation of competent cells & Transformation of *E. coli* cells with plasmid
- u) Plasmid Purification, RE Digestion & Detection of the RE-digested product
- v) Overexpression & Detection by PAGE
- w) Using restriction mapping to teach basic skills in the molecular biology lab, L. Walsh et al., *Biochem. Mol. Biol. Educ.* **35**, 199-205 (2007).
- x) Western blot analysis to illustrate relative control levels of the *lac* and *ara* promoters in *E. coli*, B. Nielsen et al., *Biochem. Mol. Biol. Educ.* **35**, 133- 137 (2007).



## Semester – VI [ January - June 2018]

### B601: Immunology

#### Unit-I

Overview of the Immune system: Types of immunity, innate, acquired, passive and active, self vs nonself discrimination, Adaptive immune response, Autoimmunity

#### Unit-II

Cells and organs of the immune system: T cell receptors, T cell receptor genes & gene rearrangements, T cell maturation, activation & differentiation, B cell generation, activation & development

#### Unit-III

Antigens and Antibodies: Immunoglobulins- structure and function, Immunoglobulin genes- Organization and rearrangement, Antibody diversity, Antigen antibody reactions, MHC (antigens and genes), Antigen processing & presentation

#### Unit-IV

Immune response: Self Non-self discrimination (mechanism), Clonal selection theory & idiotypic network hypothesis, Cytokines, The complement system, Cell mediated effector response, Leukocyte migration and inflammation, Hypersensitive reactions, Immune regulation, Immune response to infectious organisms, Vaccines, Immunodeficiency diseases (AIDS)

#### Unit-V

Immunology & applications: Transplantation immunology, Tumour immunology, Immunotechnology, Animal models. Plant immunity

#### Books Recommended:

S.No.	Author	Book
1	Goldsby, Kindt, and Osborne	Immunology
2	Janice Kuby	Immunology
3	Ivan Roitt	Essential Immunology, 8th Edition
4	Cellular and Molecular Immunology	Kathryn Austyn
5	David	Biology of Immunological Diseases
6	Richard Burry	Immunocytochemistry: A practical guide for Biomedical Research

### B 602: Animal Physiology

#### Unit-I

Cell Structure & Metabolism: Homeostasis, Mechanisms of Cellular Control, Membrane Transport, Membrane Potentials (a review). Body Control: Hypothalamic/Pituitary Axis, Mystic Rhythms

#### Unit-II

Neurons and the Nervous system: Synapses, Sense Perception, Special Senses, CNS Design: Autonomic Nervous System, Action Potential, - Basic structures of neurons and glia, Neurotransmission: Ion channels, Membrane potentials, Resting potential – Depolarization, repolarization and hyperpolarization. Electrotonic and Action potential, Mechanism of neurotransmission. Membrane channels –voltage gated, ligand gated, mechanically gated. Basics of a synapse (electrical and chemical). Introduction to central nervous system design: Structural and functional outline of the brain and the spinal cord, Hypothalamus: Osmoregulation, temperature control, and role in neuroendocrine system: Hypothalamo-hypophyseal portal system, Autonomic Nervous System (sympathetic and parasympathetic pathways). Reflex action.

**Unit-III**

Muscular system: Skeletal Muscle, Muscle Characteristics, Muscle Control, Muscle Exercise, Smooth Muscle. Cardiovascular Systems: Cardiac Muscle, Heartbeat, Cardiac Control, Blood: Hemostasis, Temperature Control, Vessels, Tissue Exchange, EKGs and Blood Pressure. Digestion: Absorption

**Unit-IV**

Respiratory Systems: Respiration, Respiratory Control. Energy Balance and Metabolism: Fuel Metabolism (both plants and Animals)

**Unit-V**

Processes: Excretion Control Salt & Water Balance, An example of a process going wrong. Diabetes. Comparative Physiology

**Books Recommended:**

S.No.	Author	Book
1	Linda S. Costanzo	Physiology: Board Review Series
2	William Ganong	Review of Medical Physiology (Lange Basic Science)
3	Guyton and Hall	Physiology Review
4	Appleton and Lange	Review of Physiology
5	Linardakis	Illustrated review of Physiology
6	C Guyton	Textbook of Medical Physiology

**B 603: Plant Physiology****Unit-I**

**Plant Cells** - Model Organisms, The Plant Kingdom, Flower Structure and the Angiosperm Life Cycle,

Plant Tissue Systems: Dermal, Ground, and Vascular

The Structures of Chloroplast Glycosylglycerides

A Model for the Structure of Nuclear Pores

The Proteins Involved in Nuclear Import and Export

Protein Signals Used to Sort Proteins to their Destinations

SNAREs, Rabs, and Coat Proteins Mediate Vesicle Formation, Fission, and Fusion

ER Exit Sites (ERES) and Golgi Bodies Are Interconnected

Specialized Vacuoles in Plant Cells

Actin-Binding Proteins Regulate Microfilament Growth

Kinesins Are Associated with Other Microtubules and Chromatin

Water and Plant Cells

Calculating Capillary Rise, Calculating Half-Times of Diffusion

Alternative Conventions for Components of Water Potential

Temperature and Water Potential, Can Negative Turgor Pressures Exist in Living Cells?

Measuring Water Potential, The Matric Potential, Wilting and Plasmolysis

Understanding Hydraulic Conductivity

Water Balance of Plants

Irrigation, Physical Properties of Soils, Leaf Transpiration and Water Vapor Gradients

Calculating Velocities of Water Movement in the Xylem and in Living Cells

Mineral Nutrition

Symptoms of Deficiency in Essential Minerals - Wade Berry, UCLA

Observing Roots below Ground

Solute Transport

Relating the Membrane Potential to the Distribution of Several Ions across the Membrane: The

Goldman Equation, Patch Clamp Studies in Plant Cells, Chemiosmosis in Action

Kinetic Analysis of Multiple Transporter Systems, ABC Transporters in Plants

Transport Studies with Isolated Vacuoles and Membrane Vesicles



**Unit-II**

Photosynthesis: The Light Reactions

Principles of Spectrophotometry, Quantum Yield

The Distribution of Chlorophylls and Other Photosynthetic Pigments

Antagonistic Effects of Light on Cytochrome Oxidation

Structures of Two Bacterial Reaction Centers

Midpoint Potentials and Redox Reactions

Oxygen Evolution, Photosystem I, ATP Synthase

Mode of Action of Some Herbicides, Chlorophyll Biosynthesis

**Photosynthesis: The Carbon Reactions**

Inorganic Carbon-Concentrating Mechanisms: CO<sub>2</sub> and HCO<sub>3</sub><sup>-</sup> – Pumps

How the Calvin–Benson Cycle Was Elucidated

Rubisco: A Model Enzyme for Studying Structure and Function

Energy Demands for Photosynthesis in Land Plants

Rubisco Activase, Thioredoxins, Operation of the C<sub>2</sub> Oxidative Photosynthetic Carbon Cycle

Carbon Dioxide: Some Important Physicochemical Properties

Three Variations of C<sub>4</sub> Metabolism

Single-Cell C<sub>4</sub> Photosynthesis, Photorespiration in CAM plants

Glossary of Carbohydrate Biochemistry, Starch Architecture

Fructans, Chloroplast Phosphate Translocators

**Photosynthesis: Physiological and Ecological Considerations**

Working with Light, Heat Dissipation from Leaves: The Bowen Ratio

The Geographic Distributions of C<sub>3</sub> and C<sub>4</sub> Plants

Calculating Important Parameters in Leaf Gas Exchange

Prehistoric Changes in Atmospheric CO<sub>2</sub>

Projected Future Increases in Atmospheric CO<sub>2</sub>

Using Carbon Isotopes to Detect Adulteration in Foods

Reconstruction of the Expansion of C<sub>4</sub> Taxa

**Translocation in the Phloem**

Sieve Elements as the Transport Cells between Sources and Sinks

An Additional Mechanism for Blocking Wounded Sieve Elements in the Legume Family

Sampling Phloem Sap, Nitrogen Transport in the Phloem

Monitoring Traffic on the Sugar Freeway: Sugar Transport Rates in the Phloem

Alternative Views of Pressure Gradient in Sieve Elements: Large or Small Gradients?

Experiments on Phloem Loading, Experiments on Phloem Unloading

Allocation in Source Leaves: The Balance between Starch and Sucrose Synthesis

Partitioning: The Role of Sucrose-Metabolizing Enzymes in Sinks

Possible Mechanisms Linking Sink Demand and Photosynthetic Rate in Starch Storers

Proteins and RNAs: Signal Molecules in the Phloem

**Unit-III**

Respiration and Lipid Metabolism

The Q-Cycle Explains How Complex III Pumps Protons across the Inner Mitochondrial

Membrane, Multiple Energy Conservation Bypasses in Oxidative Phosphorylation of Plant

Mitochondria, FoF<sub>1</sub>-ATP Synthases: The World's Smallest Rotary Motors

Transport Into and Out of Plant Mitochondria, The Genetic System in Plant Mitochondria Has

Several Special Features, Does Respiration Reduce Crop Yields?

The Lipid Composition of Membranes Affects the Cell Biology and Physiology of Plants

Utilization of Oil Reserves in Cotyledons

Assimilation of Mineral Nutrients

Development of a Root Nodule, Measurement of Nitrogen Fixation

The Synthesis of Methionine, Oxygenases

Secondary Metabolites and Plant Defense

Cutin, Waxes, and Suberin, Structure of Various Triterpenes  
The Shikimic Acid Pathway, Detailed Chemical Structure of a Portion of a Lignin Molecules

Cell Walls: Structure, Biogenesis, and Expansion  
Plant Cell Walls Play a Major Role in Carbon Flow through Ecosystems  
Terminology for Polysaccharide Chemistry  
Molecular Model for the Synthesis of Cellulose and Other Wall Polysaccharides That Consist of a Disaccharide Repeat, Matrix Components of the Cell Wall  
The Mechanical Properties of Cell Walls: Studies With *Nitella*  
Wall Degradation and Plant Defense, Structure of Biologically Active Oligosaccharins  
Glucanases and Other Hydrolytic Enzymes May Modify the Matrix

#### Unit-IV

Growth and Development  
Embryonic Dormancy, Rice Embryogenesis  
Polarity of *Fucus* Zygotes, *Azolla* Root Development  
Class III HD-Zip Transcription Factors Promote Adaxial Development through a micro RNASensitive Mechanism During Senescence Photoactive Chlorophyllide Is Converted into a Colorless Chlorophyll Catabolite  
Phytochrome and Light Control of Plant Development  
*Mougeotia*: A Chloroplast with a Twist, Phytochrome and High-Irradiance Responses  
The Origins of Phytochrome as a Bacterial Two-Component Receptor  
Profiling Gene Expression in Plants, Two-Hybrid Screens and Co-immunoprecipitation  
Phytochrome Effects on Ion Fluxes, Microarray Analysis of Shade Avoidance  
Blue-Light Responses: Morphogenesis and Stomatal Movements  
Blue-Light Sensing and Light Gradients, Guard Cell Osmoregulation and a Blue Light-Activated Metabolic Switch  
The Coleoptile Chloroplast, Phytochrome-Mediated Responses in Stomata  
Gibberellins: Regulators of Plant Height and Seed Germination  
Structures of Some Important Gibberellins and Their Precursors, Derivatives, and Inhibitors of Gibberellin Biosynthesis  
Commercial Uses of Gibberellins, Gibberellin Biosynthesis  
Environmental Control of Gibberellin Biosynthesis, Auxin Can Regulate Gibberellin Biosynthesis  
Negative Regulators of GA Response, Effects of GAs on Flowering  
DELLA Proteins as Integrators of Multiple Signals  
Cytokinins: Regulators of Cell Division  
Cultured Cells Can Acquire the Ability to Synthesize Cytokinins  
Structures of Some Naturally Occurring Cytokinins  
Various Methods Are Used to Detect and Identify Cytokinins  
The Biologically Active Form of Cytokinin Is the Free Base  
Cytokinins Are Also Present in Some tRNAs in Animal and Plant Cells  
The Structures of Opines, The Ti Plasmid and Plant Genetic Engineering  
Phylogenetic Tree of *IPT* genes  
A Root-Derived Hormone, Strigolactone, Is Involved in the Suppression of Branching in Shoots  
Cytokinin Can Promote Light-Mediated Development  
Cytokinins Promote Cell Expansion and Greening in Cotyledons  
Cytokinins Interact with Elements of the Circadian Clock  
Ethylene: The Gaseous Hormone  
Ethylene in the Environment Arises Biotically and Abiotically  
Ethylene Readily Undergoes Oxidation  
Ethylene Can Be Measured by Gas Chromatography  
Cloning of the Gene That Encodes ACC Synthase  
Cloning of the Gene That Encodes ACC Oxidase  
Ethylene Binding to ETR1 and Seedling Response to Ethylene  
Conservation of Ethylene Signaling Components in Other Plant Species  
ACC Synthase Gene Expression and Biotechnology  
The *hookless* Mutation Alters the Pattern of Auxin Gene Expression  
Ethylene Inhibits the Formation of Nitrogen-Fixing Root Nodules in Legumes



Ethylene Biosynthesis Can Be Blocked with Anti-Sense DNA  
 Abscission and the Dawn of Agriculture  
 Specific Inhibitors of Ethylene Biosynthesis Are Used Commercially to Preserve Cut Flowers  
 Abscisic Acid: A Seed Maturation and Stress-Response Hormone  
 The Structure of Lunularic Acid from Liverworts  
 ABA May Be an Ancient Stress Signal  
 Structural Requirements for Biological Activity of Abscisic Acid, The Bioassay of ABA  
 Evidence for Both Extracellular and Intracellular ABA Receptors  
 The Existence of G Protein-Coupled ABA Receptors Is Still Unresolved  
 The Yeast Two-Hybrid System  
 Yellow Cameleon: A Noninvasive Tool for Measuring Intracellular Calcium  
 Phosphatidic Acid May Stimulate Sphingosine-1-Phosphate Production  
 The ABA Signal Transduction Pathway Includes Several Protein Kinases  
 The *ERA1* and *ABH* Genes Code for Negative Regulators of the The ABA Response  
 Promoter Elements That Regulate ABA Induction of Gene Expression  
 Regulatory Proteins Implicated in ABA-Stimulated Gene Transcription  
 ABA Gene Expression Can Also Be Regulated by mRNA Processing and Stability  
 ABA May Play a Role in Plant Pathogen Responses  
 Proteins Required for Desiccation Tolerance, The Types of Coat-Imposed Seed Dormancy  
 Types of Seed Dormancy and the Roles of Environmental Factors  
 The Longevity of Seeds, Genetic Mapping Of Dormancy: Quantitative Trait Locus (QTL)  
 Scoring of Vegetative Dormancy Combined with a Candidate Gene Approach  
 ABA-Induced Senescence and Ethylene

#### Unit-V

The Control of Flowering  
 Contrasting the Characteristics of Juvenile and Adult Phases of English Ivy (*Hedera helix*) and Maize (*Zea mays*), Regulation of Juvenility by the *TEOPOD (TP)* Genes in Maize  
 Flowering of Juvenile Meristems Grafted to Adult Plants  
 Characteristics of the Phase-Shifting Response in Circadian Rhythms  
 Support for the Role of Blue-Light Regulation of Circadian Rhythms  
 Genes That Control Flowering Time, Regulation of Flowering in Canterbury Bells by Both Photoperiod and Vernalization, The Self-Propagating Nature of the Floral Stimulus  
 Examples of Floral Induction by Gibberellins in Plants with Different Environmental Requirements for Flowering, The Effects of Two Different Gibberellins on Flowering (Spike Length) and Elongation (Stem Length), The Contrasting Effects of Phytochromes A and B on Flowering  
 A Gene That Regulates the Floral Stimulus in Maize  
 Responses and Adaptations to Abiotic Stress  
 Stomatal Conductance and Yields of Irrigated Crops, Membrane Lipids and Low Temperatures  
 Ice Formation in Higher-Plant Cells, Water-Deficit-Regulated ABA Signaling and Stomatal Closure, Genetic and Physiological Adaptations Required for Zinc Hyperaccumulation  
 Cellular and Whole Plant Responses to Salinity Stress  
 Signaling during Cold Acclimation Regulates Genes That Are Expressed in Response to Low Temperature and Enhances Freezing Tolerance

#### Books Recommended:

S.No.	Author	Book
1	Hans Mohr, Peter Schopfer	Plant Physiology; Springer, 629 pages
2	Taiz and Zeiger	Plant Physiology; 4 <sup>th</sup> Edition. Sinauer
3	Hopkins WG	Introduction to Plant Physiology. 2 <sup>nd</sup> or 3 <sup>rd</sup> Edition
4	Stern KR	Introductory Plant Biology. 7 <sup>th</sup> Ed. Wm C Brown Publishers
5	Fosket	Plant Growth and Development: A molecular approach. Acad. Press. More details on how plants grow and develop.
6	Buchanan R, Grussem W and	Biochemistry and Molecular Biology of

	Jones R	Plants
7	Chrispeels MJ and DE Sadava	Plants, Genes and Crop Biotechnology. 2nd Ed. Jones and
8	Bartlett	Understanding plant biology and the potential of agricultural biotechnology

## B 604: Microbiology

### Unit-I

General Microbiology - Introduction to Microscopy, Prokaryotic Structure & Function, Microbial Nutrition, Microbial Growth, Control of Microbes, From Taxonomy through the *Archaea*: Gram Negative Bacteria, Gram Positive Bacteria, metabolism, microbial genetics, and the role of microorganisms in disease, immunity, and other selected applied areas.

Fundamentals of General Microbiology - Isolation of a broad range of nonpathogenic bacteria from natural sources, using selective and enrichment techniques, with microscopic, biochemical, and molecular identification. Related exercises include genetics, physiology, quantitation, and growth energetics. Survey of the microbial world, metabolism, biosynthesis, regulation, growth, structure, and function.

### Unit-II

Microbes and Society Focuses on activities of bacteria, viruses, and other microorganisms, and their influence on humans. Microbe-related topics include disease, bioterrorism, food, biotechnology, and ecology. Examine the nature of scientific inquiry, along with major biological concepts.

Bacterial Genetics - Molecular genetics: description of fundamental genetic processes such as mutation, repair, genetic exchange, recombination, and gene expression. Use of genetic strategies to analyze complex biological processes. Focuses on prokaryotic organisms. Signal transduction in bacteria

### Unit-III

Evolution of Prokaryotic Diversity - Evolution, diversity, and genomics of prokaryotic microorganisms, Enrichment, isolation, and molecular phylogenetic characterization of selected prokaryotic organisms. Prokaryotic Diversity - Structure, biochemical properties, and genetics of the major groups of prokaryotes.

Microbial Ecology - Consideration of the various roles that microorganisms, particularly bacteria and cyanobacteria, play in environmental processes. The interrelationships among microorganisms and the effects of the physical, chemical, and biological properties of their environment are discussed and assessed. Microbial ecology; food, industrial and medical microbiology Symbiosis Aquatic Ecology, Terrestrial Ecology, Industrial Microbiology, Food Microbiology

### Unit-IV

Medical Bacteriology - Medically important bacterial pathogens in terms of the clinical, therapeutic, and epidemiological aspects of diseases caused by them, molecular mechanisms of pathogenesis and their identification in the clinical laboratory, procedures for isolation and identification of pathogenic bacteria, testing their susceptibility to antibiotics. Bacterial Pathogenesis: Introduction, Genetic tools used for bacterial pathogenesis study; Bacterial cell-cell communications and biofilm formation, Bacterial genomics, lateral transfer, phage, Vertebrate microbial communities in health and disease, Strategies for bacterial adhesion and invasion

Medical Mycology and Parasitology - Consideration of medically important fungi and parasites, with emphasis on their biology in relation to disease and its laboratory diagnosis.

### Unit-V

Molecular Mechanisms of Bacterial Pathogenesis Mechanisms of bacterial pathogenesis explored at the molecular, genetic, and cellular levels through selected models as presented in the current scientific literature. Molecular and Medical Microbiology recent advances in molecular biology of microbial pathogenesis or the current research of the participants is presented and discussed critically.

Protozoan infections: Introduction to protozoa, A survey of the major protozoan infections of humans including a brief description of the parasite life cycles and a brief discussion of the clinical diseases seen during these infections.



Biology and pathogenesis of Plasmodium. life cycle Plasmodium parasites and pathology of human malaria, biochemical and cell biological similarities and differences with other apicomplexa (Babesia, Cryptosporidium, Toxoplasma, etc.), and implications for therapeutic development. Biology and pathogenesis of Toxoplasma, Leishmania, Trypanosoma.

**Books Recommended:**

S.No.	Author	Book
1	Thomas D Brock	Brock's Biology of Microorganisms
2	Patrick R Murray	Medical Microbiology: with STUDENT CONSULT Access
3	John M Barry	The Great Influenza: The Story of the Deadliest Pandemic in History
4	Alfred E Brown	Benson's Microbiological Applications: Laboratory Manual in General Microbiology (Spiral-bound)
5	Ananthanarayan and Paniker Orient Blackswan	Textbook of Microbiology: Medical microbiology

**CB601: Biophysical Chemistry**

**Unit-I**

Physical properties of water: Structure, water as solvent, The hydrophobic effect, osmosis and Diffusion. Introduction to Biomolecules: Nucleic Acid, Protein - Polymer Description of Macromolecular Structure, Intermolecular and Intramolecular forces, Non Covalent Interaction

**Unit -II**

Hydrodynamic properties: Diffusion and sedimentation, determination of molecular weight from sedimentation and diffusion; Introduction of Ultra Centrifugation, Dynamic Light Scattering and Electrophoresis.

Spectroscopic properties of proteins and nucleic acid: UV/Vis, Intrinsic fluorescence, Circular Dichroism

**Unit -III**

The concept and application of Chemical and Physical equilibria in Biological system, The equilibrium constant and Standard Gibbs Free energies of reactants and products, Temperature dependence of the equilibrium constant, Double Strand formation in nucleic acid, Ligand-protein binding, Protein denaturation and stability, Introduction of DSC and ITC

**Unit -IV**

Protein folding kinetics and Biophysical methods, Misfolding and aggregation ; Physical basis of conformation diseases, Therapeutic approaches to protein misfolding diseases.

**Unit -V**

Introduction to basic principles of protein X-ray crystallography, protein NMR, Small Angle X-ray scattering (SAXS), and Electron microscopy (EM).

**Books Recommended:**

S.No.	Author	Book
1	Tinoco, Sauer, Wang & Puglisi	Physical Chemistry: Principles and Applications in the Biological Sciences
2	Peter Atkins and Julio de Paula	Physical Chemistry for the Life Sciences

## H 601 Ethics of Science and IPR

### Unit-I

Introduction – causes of unethical acts, ignorance of laws, codes, policies and Procedures, recognition, friendship, personal gains; Bioethics: Definition – moral, values, ethics; Role and importance of ethics in biology; Professional ethics – professional conduct

Ethical decision making, ethical dilemmas; Teaching ethical values to scientists, good laboratory practices, good manufacturing practices, laboratory

Basic Approaches to Ethics; Posthumanism and Anti-Posthumanism;

Bioethics: legal and regulatory issues;

### Unit-II

Bioethics in healthcare, agriculture, modern biology, biotechnology, animal welfare & right / animals in research, wildlife conservation and management, commercialism in scientific research

Bioethics and cross-cultural bioethics – Autonomy, Rights, Beneficence, Do No Harm, Justice, Confidentiality, Animal Rights, Environmental ethics, Decision-Making Perceptions of Ethical Biotechnology 'Moral' is not the same as Ethical, Mixed Perception of Benefit & Risk, Reasoning behind Acceptance or Rejection of Genetic Manipulation, Concerns about Consuming products of GMOs.

Past and Present 'Bioethical Conflicts' in Biotechnology- Interference with Nature , Fear of Unknown, Regulatory Concerns, Human Misuse Future 'Bioethical Conflicts' in Biotechnology - Changing perception of Nature, Human Genetic Engineering

### Unit-III

Ethical issues related to Synthetic biology:

Engineering DNA-based biological circuits, including but not limited to standardized biological parts;

Defining a minimal genome/minimal life (top-down); Constructing protocells, i.e. living cells, from scratch (bottom-up), Creating orthogonal biological systems based on a biochemistry, e.g. non-ATGC DNA bases or non-DNA non-RNA nucleic acids, so called XNA

### Unit-IV

Introduction to IPR; Types of Intellectual property – Patents, Trademarks

Copyrights and related rights; Traditional vs. Novelty; Importance of intellectual property rights in the modern global economic environment, Importance of intellectual property rights in India; IPR and its relevance in biology and environmental sciences;

Case studies and agreements - Evolution of GATT and WTO and IPR provisions under TRIPS;

Madrid agreement; Hague agreement; WIPO treaties; Budapest treaty; Indian Patent Act (1970)

### Unit-V

Patents: Definition, patentable and non patentable inventions; types of patent application – Ordinary, Conventional, PCT, Divisional, and Patent of addition; Concept of Prior Art; Precautions while patenting disclosure / nondisclosure; Time frame and cost; Patent databases, Searching International databases; Patent licensing and agreement; Patent infringement – meaning, scope, litigation, case studies. Patenting rules – European Scenario, US Scenario, Australia Scenario, Indian Scenario, Non Patentable IP and Patentable IP in Indian Patent Act

Rights of patents – Infringement of patent rights Remedies for infringement of patent rights; Patentability and emerging issues

### Books Recommended:

S.No.	Author	Book
1	Lesk	Introduction to Bio Informatics, OUP
2	Cynthia Gibas and Per Jambeck,	Developing Bioinformatics Computer Skills
3	Atwood, Pearson Education	Introduction to Bioinformatics
4	Tisdall, SPD	Beginning Perl for Bio-informatics
5	Smith, D.W., 1994	Biocomputing: Informatics and Genome Project
6	Baxevanis, A.D., Quellette, B.F.F.,	Bioinformatics: A practical Guide to the Analysis of Genes and Proteins



**BL 601: Biology Laboratory**  
**(Animal Physiology + Plant Physiology + Immunology + Microbiology+ Bioinformatics)**

**1. ANIMAL PHYSIOLOGY**

- a) Animal cell culture and microscopy
- b) Gross anatomy of the animal brain & Staining of mouse brain sections
- c) Wound Healing Assay

**2. IMMUNOLOGY**

- d) Isolations of monocytes/macrophages- properties; Isolation of Lymphocytes- T and B cell identification & Lymphocyte Activity.
- e) Separation of WBC & RBC; counting by Haemocytometer
- f) Serum Electrophoresis
- g) ELISA - direct & indirect
- h) Ag detection & Ab detection
- i) Widal – Tube & Slide
- j) VDRL
- k) Blood typing & Pregnancy hCG Ag
- l) Double diffusion
- m) Immunoelectrophoresis
- n) Radial Immunodiffusion

**3. PLANT PHYSIOLOGY**

- p) *Arabidopsis thaliana* - model organism and its development
- q) *Funaria hygrometrica* - differentiation from chloronema to caulonema to bud formation
- r) Callus formation from carrot cells

**4. Bioinformatics:**

- DNA sequence analysis using BLAST; sequence pattern, motifs and profiles.
- Prediction of secondary structure of proteins
- Prediction of tertiary structure of (fold recognition, homology search)
- Molecular modeling and dynamics: using small oligonucleofides and small protein with known crystal structure (available from data bank)
- Drug designing – using available data Applications of bio informatics – open ended / small project.

**FOURTH YEAR**

**Semester – VII [ July – December 2018]**

**B 701: Neurobiology**

**Unit-I**

The glial system: Generation of Astrocytes, Oligodendrocytes, and Schwann cells. Function of glia in normal brain and in neuroprotection.

Chemical composition of the brain: metabolism (utilization and uptake of glucose and amino acids). Blood-Brain barrier.

**Unit-II**

Neurotransmitters: Synthesis, storage, release, uptake, degradation and action of neurotransmitters, Acetyl choline, GABA, Serotonin, Dopamine, Glutamate, Nitrous oxide, etc. Receptors: different subtypes (cholinergic, dopaminergic, adrenergic, and glutamatergic), mechanism of action, Agonists and Antagonists – their mode of action and effects. Exocytosis of neurotransmitter – Role of synapsins, synaptogamins, SNAP, SNARE and other proteins in docking, exocytosis and recycling of vesicles.

**Unit-III**

Sleep and Learning and memory: Mechanism of short-term memory and Long-term memory (longterm potentiation). Role of sleep in memory consolidation. Electroencephalogram. Role of second messenger pathways in learning and memory process. Role of synaptic plasticity.

**Unit-IV**

Sensory organs:

Vision: Biochemistry of vision: Rod and cone cells, mechanism and regulation of vision, color vision, visual field, visual acuity. Visual pathway and topographic mapping.

Audition: functional anatomy of the middle and inner ear. Amplification of sound. Functional anatomy and mechanism of detection of specific sound frequency in the inner ear. Mechanism of action of the mechanosensory receptors in the inner ear.

**Unit-V**

Chemical senses:

Olfaction: The olfactory pathway, mechanism and the combinatorial code of detecting a smell.

Taste: Mechanism of taste perception.

Touch/pain: The touch/pain/temperature pathway (ascending and descending). Higher order integration in the brain.

Pathologies of the nervous system: Molecular basis of Parkinson's disease, Alzheimer's disease, Schizophrenia, Myasthenia gravis and Multiple sclerosis, stress and antidepressants.

**Books Recommended:**

S.No.	Author	Book
1	Ferdinand Hucho	Neurochemistry
2	MP Spiegel	Basic Neurochemistry
3	Koenig and Edward	Cell Biology of the Axon, Series: Results & Problems in Cell Differentiation, Vol. 48
4	Eric Kendel, JH Schwartz, T Jessel	Principles of neural Sciences
5	A Guyton and J Hall	Textbook of medical Medical physiology

**B 702: Immunology-II (Immunity and Disease)****Unit-I**

Host-Pathogen relationship

Diseases caused by Viruses and the immune response to them- HIV and AIDS-immune responses

**Unit-II**

Bacterial diseases – and the immune response to bacteria

Vaccines- mechanisms, types of vaccines

**Unit-III**

Parasites – protozoan parasites, parasitic worms and the immune response to them- eg malaria, leishmaniasis, worm infestations

**Unit-IV**

Immediate Hypersensitivity and allergy, anaphylaxis

Hypersensitivity and chronic inflammatory diseases- tuberculosis and leprosy

Cancer immunology

**Unit-V**

Autoimmune diseases- generalized- SLE, Rheumatoid arthritis; localized- multiple sclerosis

Diseases due to immune cross reactivity- Rh incompatibility, transfusion, transplantation

Inherited immune diseases



**Books Recommended:**

S.No.	Author	Book
1	Charles A Janeway, JP Travers, Mark Walport and Mark J Shlomchik	Immunobiology, 5th edition; The Immune System in Health and Disease
2	Baron S, Galveston	Medical Microbiology; 4 <sup>th</sup> Edition; University of Texas Medical Branch at Galveston
3	RA Goldsby <i>et al.</i>	Kuby's Immunology
4	E Benjamini, R Coico and G Sunshine	Immunology- A short Course
5	Roitt, Brostoff and Male	Immunology
6	William Paul	Fundamentals of Immunology
7	Tizard	Immunology
8	Abbas <i>et al.</i>	Immunology

**B 703: Developmental Biology****Unit-I**

Basic concepts of molecular regulation of development: Transcription factors in differential gene expression; morphogens and axis formation; autocrine and paracrine regulation. How cell proliferation, apoptosis, and fate specification determine developmental processes.

Fertilization: Structure of oocytes and spermatocytes. The process of fertilization.

**Unit-II**

Comparative study of early embryonic development: (*Caenorhabditis elegans*, amphibians, birds, and mammals), Cleavage formation, Gastrulation

Axis formation: Signaling cascades and molecular understanding of anteroposterior, mediolateral, and dorsoventral axes development.

**Unit-III**

Organogenesis in vertebrates: Germ layer formation. Regulation of formation of the somites, heart, kidney, blood vessels, and limb. Changes in circulation pattern between fetus and newborn.

Metamorphosis and regeneration process: Hormonal control of metamorphosis in amphibians and insects; wing imaginal disc formation in *drosophila*. Regeneration in planeria and that of vertebrate limb.

**Unit-IV**

Stem cells: Concepts of totipotent, pluripotent, and multipotent cells. Factors regulating "stemness" of a cell. Embryonic vs. adult stem cells. Sources of stem cells in vertebrates and their applications.

Developmental disorders and aging: Regulatory role of genetic and environmental factors. Role of carcinogens and teratogens.

**Unit-V**

Development processes in plants: How are the mechanisms different from that of animal development?

Gametogenesis, pollination, and fertilization processes in angiosperms. Hormonal regulation of seed dormancy and the process of germination. Root and shoot development mechanisms. Reproductive phase: photoperiod sensitivity and molecular regulation of flowering process.

Epigenetic and environmental control of development: Sexual dimorphism, sex determination, X inactivation. Environ-elicited phenotypic changes. Defense mechanism-related changes.

**Books Recommended:**

S. No.	Author	Book
1	Alberts <i>et al.</i>	Molecular Biology of the Cell
2	SF Gilbert	Developmental Biology
3	Lewin Benjamin	Gene VIII

4	PO Moody	Introduction to Evolution, 1970,
5	Dobzhansky et al.	Evolution, W. H. Freeman. New York
6	SW Fox and K Dose	Molecular Evolution and the Origin of Life,
7	FJ Ayala and JW Valentine	Evolving: The theory and processes of Organic evolution
8	EO Dodson	Evolution: Process and Product
9	MW Strickberger	Evolution, 1979, James and Barlett International

### B 704: Imaging Technology in Biological Research

#### Unit-I

The power of ten (understanding how small cells and the sub-cellular contents are)  
An introduction to light and optics, exploring with lenses (what are lenses, looking through them, understanding the concept of magnification, mirrors, angles of reflection, refraction, prisms and colors)

#### Unit-II

Fundamentals of illumination (ray diagrams, types of light sources, LEDs, power levels, coherence of light, elliptical reflectors)  
Exploring microscopes (short history, magnifying glass, simple and compound microscopes, electron Microscopes, stereomicroscope)

#### Unit-III

Fluorescence microscopy (Understanding fluorescence, Fluorescence protein technology, GFP, YFP)  
two-photon fluorescence microscopy, matrix-assisted laser desorption/ionization mass spectrometry (MALDI-MS) imaging

#### Unit-IV

Live cell imaging (confocal microscopes), Differential interference contrast (DIC) images  
Comparing Confocal and Widefield Fluorescence Microscopy  
Atomic force microscopy and optical tweezers force spectroscopy

#### Unit-V

##### NMR Imaging

Spatially nonresolved NMR spectroscopy; low-field NMR instruments;  $^1\text{H}$ -nuclear magnetic resonance (NMR) microimaging ;  $^1\text{H}$ -magic angle spinning NMR spectroscopy; MAS- $^{13}\text{C}$  NMR spectroscopy  
Spectral-resolution enhancement using magic angle spinning

#### Books Recommended:

S.No.	Author	Book
1	Ulf Grenander, Y Chow and Daniel M Keenan	Hands: A Pattern Theoretic Study of Biological Shapes (Research Notes in Neural Computing) (Volume-2)
2	Valery V Tuchin, Lihong Wang and Dmitry A Zimnyakov	Optical Polarization in Biomedical Applications (Biological and Medical Physics, Biomedical Engineering)
3	RM Lambrecht	Biological Models in Radiopharmaceutical Development (Developments in Nuclear Medicine)
4	Michael D Powers and Janet Poland	Asperger Syndrome and Your Child: A Parent's Guide
5	Philippe Sansonetti	Bacterial Virulence: Basic Principles, Models and Global Approaches (Infection Biology (VCH)
6	Richard Nuccitelli, Leslie Wilson and Paul T Matsudaira	A Practical Guide to the Study of Calcium in Living Cells, Volume 40 (Methods in Cell Biology)
7	Warren CW Chan	Bio-Applications of Nanoparticles (Advances in Experimental Medicine and Biology)
8	Bertram Manz, Kerstin Müller,	Water Uptake and Distribution in Germinating

	Birgit Kucera, Frank Volke, and Gerhard Leubner-Metzger	Tobacco Seeds Investigated in Vivo by Nuclear Magnetic Resonance Imaging. Plant Physiology, July 2005, Vol. 138, pp. 1538–1551
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### Semester – VIII [ January – June 2019]

#### B 801: Virology

##### Unit-I

Introduction to Virology: definition, properties and origin of viruses  
 Virus architecture and nomenclature  
 Virus replication cycle  
 Basic virological methods  
 Basics of virus entry, spread and transmission

##### Unit-II

Host resistance to viral infection: immune responses  
 Vaccines and antiviral chemotherapy: the prevention and treatment of viral diseases  
 Epidemiology  
 Exploiting viruses as gene therapy and vaccine vectors

##### Unit-III

Viruses and cancer: oncoviruses and oncolytic viruses  
 Polioviruses and other single-stranded positive-strand RNA viruses  
 Rabies and other single-stranded nonsegmented negative-strand  
 Influenza virus and other single-stranded segmented negative-strand RNA viruses.

##### Unit-IV

Evolution of viruses: new and reemerging viruses  
 Herpesviruses (nuclear large double-stranded DNA viruses)  
 Poxviruses (cytoplasmic large double-stranded DNA viruses)  
 HIV and other retroviruses

##### Unit-V

Hepatitis B virus (reverse-transcribing DNA virus) and other viruses causing hepatitis  
 Prion diseases  
 Plant viruses  
 Bacteriophages

#### Books Recommended:

S.No.	Author	Book
1	L Collier, J Oxford and Paul Kellam	Human Virology (4 <sup>th</sup> edition),
2	SJ Flint, LW Enquist, VR Racaniello and AM Skalka	Principles of Virology (3 <sup>rd</sup> edition) 2009
3	AJ Cann	Principles of Molecular Virology,
4	Teri Shors, Jones and Bartlett	Understanding Viruses
5	NJ Dimmock, A Easton, K Leppard	Introduction to Modern Virology 6th edition,
6	David M Knipe, Peter M Howley, MD Diane E Griffin, Robert A Lamb, Malcolm A Martin, Bernard Roizman, Stephen E Straus	Field's Virology. 6th edition



7	AJ Zuckerman, JE Banatvala, P Griffiths, B Schoub and P Mortimer	Principles and Practice of Clinical Virology (6th edition)
8	G Kudesia and T Wreghitt: Cambridge Clinical Guide	Clinical and Diagnostic Virology
9	L. Sompayrac	How Pathogenic Viruses Work;

## B 802: Biotechnology-I

### Unit-I

Basic principles of genetic engineering:

Methods of creating recombinant DNA molecule, splicing, properties of restriction endonucleases and their mode of action. Cloning vectors (lambda phage plasmid, M-13 phage, cosmid, shuttle vectors, yeast and viral vectors, expression vectors), construction of DNA library, Subtraction cDNA cloning, genomic vs cDNA library - Expression libraries and vectors for protein synthesis, protein purification, protein solubilization, protein export, RNA probes, BACs, PACs and cosmid vectors, Yeast vectors and YACs

### Unit-II

Transgenic animals [Selectable markers for animal cells eg HAT, methotrexate Reporter genes for promoter analysis (Lac Z, GFP) vectors (Baculoviruses) microinjection, retroviruses, Embryonic stem cells), Transgenic mouse / Super mouse – (MT promoter fused to human growth hormone) (isolation of cloned proteins from goat milk). Viruses as gene-transfer Methods for production of transgenic mice (Pronuclear Transgenic Goats Whole animal cloning eg Dolly, Knock-out, knock-down, knock-in technology, Site-specific recombination using Cre-recombinase LOX system, Gene therapy eg SCID]

### Unit-III

Transgenic plants [Agrobacterium mediated transformation, Ti plasmid, Transgenic tobacco expressing luciferase gene, Bt Cotton, Herbicide-resistant plants, Plant viruses as vectors (eg CaMV virus)]. Application of genetic engineering in medicine and agriculture, vaccine production.

### Unit-IV

Chemical synthesis of gene and engineering artificial life . Selection/screening: Analysis of genomic DNA by Southern hybridization, Northern and Western blotting techniques, Restriction mapping: Restriction fragment length polymorphism (RFLP). DNA sequencing and analyses techniques: plus and minus, dideoxynucleotide, Maxam and Gilbert, deep sequencing and next gen sequencing, microarray technology and hybridisations.

### Unit-V

DNA manipulation techniques:

Preparation of radiolabelled and synthetic probes, Amplification of DNA by polymerase chain reaction (PCR), Site directed mutagenesis, Gene transfer methods for animals and plants; Agrobacterium mediated gene transfer, electroporation and particle gun. Cell and tissue culture in plants and animals: Primary culture; Cell line; Cell clones; Callus cultures; Somaclonal variation; Micropropagation; Somatic embryogenesis; Haploidy; Protoplast fusion and somatic hybridization; Cybrids; Gene transfer methods in plants and in animals; Transgenic biology; Allopheny; Artificial seeds; Hybridoma technology.

## B 804: Biotechnology-II

### Unit-I

Principles of plant breeding: Important conventional methods of breeding self and cross pollinated and vegetatively propagated crops; Non-conventional methods; Polyploidy: Genetic variability; Plant diseases and defensive mechanisms. Ethics of GM crops and animal cloning . Model organisms - *S. cereviceae*, *Dictostylium*, *Caenorhabditis elegans*, *Arabidopsis*, Zebra Fish, Mouse, *Drosophila*

**Unit-II****Industrial Biotechnology-I**

Bioprocess Technology [basics of bioreactor kinetics and mathematical equations regarding bioreactors, scale-up and aeration of bioreactors in detail, Kinetics of microbial growth, substrate utilization and product formation: Batch, Fed- Batch and continuous processes, Scale up concepts with respect to fermenter design and product formation, Gas exchange and mass transfer: O<sub>2</sub> transfer, critical oxygen concentration, determining the oxygen uptake rate, Solid state fermentation. Common examples: Biopolymers: Xanthan , melanin , adhesive proteins , rubber, poly hydroxyl alkaloids

**Unit-III****Industrial Biotechnology-II**

Downstream Processing - Flocculation and floatation, Filtration, Centrifugation, Cell disruption, Liquid extraction, Precipitation, Adsorption, Dialysis, Reverse osmosis, Chromatography, Crystallization and drying, Biodegradation of xenobiotic compounds: Remediation and Biotechnology - Priority pollutants and their health effects, Microbial basis of biodegradation, Bioremediation (phyto and metal), Environmental and industrial pollution control, Biopesticides, Microbial plastics, Solid waste management

**Unit-IV****Medical Biotechnology -**

- a. Small Biological Molecules: - ascorbic acid, indigo, amino acids, lycopene, succinic acid production, Antibiotics, Tissue Engineering - Growth Factors and morphogens: signals for tissue engineering and whole organ development, extracellular Matrix: structure, function and applications to tissue engineering, Cell adhesion and migration, Inflammatory and Immune responses to tissue engineered devices
- b. Biomaterials - Polymeric scaffolds, Calcium Phosphate Ceramics for bone tissue engineering, Bio mimetic materials, Nanocomposite scaffolds

**Unit-V****Nanotechnology-**

- a. Introduction to nanotechnology and nano-biotechnology, Nanomaterials and their uses.
- b. Nanoparticles derived from biological molecules, Synthesis of nanoparticles: strategies, biological methods, general properties and characterization methods
- c. Applications of nanotechnology: Nanosensors, Carbon nanotubes and their applications in biology
- d. Environmental and safety issues with nanoparticles.

**Books Recommended:**

S.No.	Author	Book
1	Benjamin Lewin	Gene VII, Oxford Publishers
2	T A Brown	Genome, Second edition,
3	Old and Primrose	Principles of Gene Manipulation;
4	Simmons and Gardner	Principles of genetics;
5	Donald Voet and Judith Voet	Biochemistry 3 <sup>rd</sup> Edition,
6	T D.Watson and others	Molecular Biology of the Gene , 6 <sup>th</sup> Edition
7	GM Cooper	The Cell: A molecular approach: Library of Congress cataloging in publication data.
8	Griffiths A and Miller J	An introduction to genetic analysis; Freeman
9	Lodish H and Berk	A Molecular cell biology;
10	Sambrook J, Russell	Molecular cloning:- Vol I, II , III; CSHL Press
11	TA Brown	Gene cloning and DNA analysis;
12	B Glick, J Pasternak & C Patten	Molecular Biotechnology- principles and applications of Recombinant DNA, 4th
13	K. Deb and Satish Totey	Stem Cells Basics and Applications;
14	Gary Stein and Maria B et al.	Human Stem Cell Technology and Biology;

15	R. Ian Freshney, Glyn N. Stacey, Jonathan M. Auerbach	Culture of Human Stem Cells. John Wiley & Sons
16	Bernard R Glick, Jack J Pasternak, Cheryl L Patten	Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press
17	Robert Lanza, Robert Langer, Joseph P Vacanti	Principles of Tissue Engineering
18	Inderbir Singh and GP Pal	Human Embryology; MacMillan Publishers
19	Thomas W Sadler	Langman's Medical Embryology;
20	F Gilbert	Developmental Biology; 6 <sup>th</sup> Edition;
21	Gordana Vunjak-Novakovic, R Ian Freshney	Culture of Cells for Tissue Engineering;
22	SB Primrose and Twyman	Principles of gene manipulation
23	RW Old and SB Primrose	Principles of gene manipulation
24	Watson	Recombinant DNA
25	TA Brown	Gene cloning and DNA analysis
26	SC Rastogi <i>et al.</i> ,	Bioinformatics-Methods and Applications
27	A Caldwell <i>et al.</i> ,	Integrated Genomics; Wiley Publishers
29	D Clark, N Pazdernik	Bioprocess Technology- Biotechnology- Applying the genetics to revolution
30	Wulf Crueger and Anneliese Crueger	Biotechnology: A Textbook of Industrial Microbiology; Panima Publishers, New Delhi
31	Michael L Shuler, Fikret Kargi	Bioprocess Engineering: Basic concepts
32	Stanbury PF, Whitaker A, Hall SJ	Principles of Fermentation Technology; Butterworth-Heinemann
33	Glazer AN and Nikaido H	Microbial Biotechnology: Fundamentals of Applied Microbiology
34	Sulabha Kulkarni	Nanotechnology principles and practices;
35	David S Goodsell	Bionanotechnology: Lessons from Nature;
36	James A Schwarz, Cristian I Contescu and Karol Putyera	Dekker Encyclopaedia of Nanoscience and nanotechnology;

## B 803: Bioinformatics

### Unit-I

Computer related introductory topics: History of development of computers, Basic components of computers, Hardware; CPU, input, output, storage devices. Software; operating systems, Programming languages (Machine, Assembly and Higher level)

Application software: Introduction to MSEXCEL-Use of worksheet to enter data, edit data, copy data, move data. Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients etc. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. Introduction to MSWORD word process or editing, copying, moving, formatting, Table insertion, drawing flow charts etc.

### Unit-II

Bioinformatics core topics: Introduction to Internet and use of the same for communication, searching of database, literature, references etc. Introduction to Bioinformatics, Databank search- Data mining, Data management and interpretation, BLAST, Multiple sequence alignment, Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions, Genes, Primer designing, Phylogenetic Analysis, Genomics and Proteomics.

### Unit-III

Biological databases: Introduction to variety of data sources. Population, sample, Classification and modeling of Data. Quality of data, Private and public data sources.



Example Databases:

- (a) Nucleic acid databases (NCBI, DDBJ, and EMBL). (b) Protein databases (Primary, Composite, and Secondary)  
 (c) Specialized Genome databases: (SGD, TIGR, and ACeDB) (d) Structure databases (CATH, SCOP, & PDBsum)

#### Unit-IV

Alignment: Basics and techniques, Local alignment and Global alignment Pairwise sequence alignment: NEEDLEMAN and Wunsch algorithm, Smith and Waterman algorithm, The Dot Plot, Dynamic Programming Algorithm. Multiple Sequence Alignment (MSA): Definition, Objective, Consensus, Methods for MSA: Heuristic approach, Dynamic programming approach and their combinations. Complexity analysis. Phylogenetic Analysis: Molecular-Phylogenetics, Phylogenetic-trees, Terminology of tree-reconstruction, rooted and un-rooted trees, gene vs species trees and their properties. Algorithms /methods of phylogenetic analysis: UPGMA, Neighbor-Joining Method.

#### Unit-V

Protein structure analysis and prediction: Identification/assignment of secondary structural elements from the knowledge of 3-D structure of macromolecule using DSSP and STRIDE methods , Prediction of secondary structure: PHD and PSI-PRED method Tertiary (3-D) Structure prediction: Fundamentals of the methods for 3D structure prediction (sequence similarity/identity of target proteins of known structure, fundamental principles of protein folding etc.) Homology Modeling, fold recognition, threading approaches, and ab-initio structure prediction methods. Genomics: Basic concepts on identification of disease genes, role of bioinformatics-OMIM database, reference genome sequence, integrated genomic maps, gene expression profiling; identification of SNPs, SNP database (dbSNP). Role of SNP in Pharmacogenomics, SNP arrays  
 Drug discovery and Development : - Introduction to Drug Design and Development, Drug targets, Lead Identification and Modification, Computer-Aided Drug Design, Drug Delivery, Pre-clinical and Clinical Testing  
 Applications of Bioinformatics: Pharmaceutical industries, immunology, agriculture, forestry; Legal, ethical and commercial ramifications of bioinformatics; Bio-sensing

#### Books Recommended:

S.No.	Author	Book
1	E Wayne W Daniel	Biostatistics: A foundation for Analysis in the Health Sciences
2	Prem S Mann	Introductory Statistics. 5 <sup>th</sup> Edition;
3	Olive Jean Dunn	Basic Statistics: A primer for Biomedical Sciences
4	Auram Gold Stein	Biostatistics: An introductory text
5	Taro Yamane	Statistics: An Introductory Analysis;
6	C Stan Tsai	Computational Biochemistry;

### FIFTH YEAR

#### Semester – IX [ July – December 2019]

#### BPr 901 Research Project\*

#### Note: Project Work\*\*

*The project has to be carried out in recognized national laboratories or UGC-recognized universities. No student will be allowed to carry out project work in private laboratories/ college/ institutions, excluding the colleges recognized as research centers by the RDC of Pt. Ravishankar Shukla University, Raipur.*

**Semester – X [ January – June 2020]**

<b>E 1001</b>	<b>Elective I</b>
<b>E 1002</b>	<b>Elective II</b>
<b>E 1003</b>	<b>Elective III</b>
<b>E 1004</b>	<b>Elective IV</b>

**Electives:**

1. Toxicology and clinical research
2. Molecular modeling and drug design
3. Ethology
4. Parasitology
5. Reproductive biology
6. Occupational diseases (infectious incl)
7. Plant pathology
8. Plant communication
9. Animal migration
10. Commercial products from plants and animals
11. Biology of food industry
12. Transgenics
13. Ethical issues in biology and medicine
14. Physical biology
15. Astrobiology
16. Biology of traditional medicines
17. Translational biology
18. Science writing and communication
19. Forensic science
20. Epigenetics
21. On-line courses

Total pages: 1-11

**Center for Basic Sciences  
(CBS)  
SCHEME OF EXAMINATION  
&  
COURSE STRUCTURE  
Of  
SEMESTER IX and X  
M.Sc. Integrated (Biology Stream)  
UNDER  
FACULTY OF LIFE SCIENCE  
EFFECTIVE FROM JANUARY 2020**



Center of Basic Science  
Pt. Ravishankar Shukla University  
Raipur (C.G.) 492010  
PH: - 0771-2262864  
WEBSITE: -[www.prsu.ac.in](http://www.prsu.ac.in)

Approved by Board of Studies in Bio Science  
Pt. Ravishankar Shukla University, Raipur (C.G.)



CENTER FOR BASIC SCIENCES  
Pt. Ravishankar Shukla University, Raipur

5-Year Integrated M.Sc. Biology  
Under  
Faculty of Life Science

SEMESTER-IX (Biology Stream)

Project (BPr901) Evaluation Scheme

20 Credits

		Marks
1.	Project Report/Dissertation (Certified by the Supervisor of the Institute)	150
2.	Seminar based on Project	150
3.	Viva-Voce based on Project report and Seminar	100
	Total Marks	400

*Witham*  
17-1-20

*Singh*  
17/01/2020

*ASH*  
17/1/2020

*ajay*  
17/1/20

*Dushan*  
17/1/20

*Deewoo*  
17/01/2020

*Shukla*  
17-1-20

*Dpt*  
17-01-2020

**CENTER FOR BASIC SCIENCES**  
**Pt. Ravishankar Shukla University, Raipur**

**5-Year Integrated M.Sc. Biology**  
**Under**  
**Faculty of Life Science**

**SEMESTER-X (Biology Stream)**

Subject		Subject Contact hrs/per week Theory+Tutorial	Credits
BE 1001	Electives I	[4 + 1]	5
BE 1002	Electives II	[4 + 1]	5
BE 1003	Electives III	[4 + 1]	5
BE 1004	Elective IV	[4 + 1]	5
		Total	20

Min. 20  
(Total 240 credits)

\*Any four papers out of the available seven papers (as mentioned in the next pages) shall be in operation on availability of the instructors with more than 50% of students opting for them.

*Maitani*  
17.1.20

*Sharma*  
17/01/2020

*Mishra*  
17/1/2020

*ajay*  
17/1/20

*Randhawa*  
17/1/20

*Mishra*  
17/01/2020

*Randhawa*  
17.01.2020

*Sharma*  
17.1.20



## Electives for X Semester-Biology Stream

### 1. Proteomics and Genomics

#### Unit-I

Introduction and scope of proteomics; Protein separation techniques: ion exchange, size-exclusion and affinity chromatography techniques; Polyacrylamide gel electrophoresis; Isoelectric focusing (IEF); Two dimensional PAGE for proteome analysis; Image analysis of 2D gels.

#### Unit-II

Introduction to mass spectrometry; Strategies for protein identification; Protein sequencing; Protein modifications and proteomics; Applications of proteome analysis to drug.

#### Unit-III

Protein-protein interaction (Two hybrid interaction screening); Protein engineering; Protein chips and functional proteomics; Clinical and biomedical application of proteomics; Proteome database; Proteomics industry.

#### Unit-IV

Introduction and Classification of genomics; Methods of preparing genomic DNA; Genome sequencing methods (next-generation sequencing); Databases of genomes; Genetic mapping; Mapping of human genome; Human genome project; HapMap Project, The 1000 genome project, and The ENCODE Project.

#### Unit-V

Gene variation and Single Nucleotide Polymorphisms (SNPs); Expressed sequenced tags (ESTs); Gene disease association; DNA fingerprinting; Microarray based techniques for RNA analysis; metagenomics.

#### Suggested readings:

1. Cantor and Smith, Genomics. John Wiley & Sons, 1999.
2. Introduction to Genomics - Arthur M Lesk, Oxford University Press, 2007.
3. R.M. Twyman, Principles of Proteomics, BIOS Scientific Publishers, 2004.
4. P. Michael Conn, Handbook of Proteomic Method. Humana Press, Totowa, New Jersey, USA, 2003.
5. L.Stryer, Biochemistry, W. H. Freeman and Co., New York, 2007.

### 2. Nanobiotechnology

#### Unit-I

The nanoscale dimension and paradigm, Various definitions and Concept of Nanobiotechnology, Historical background, Development. Fundamental sciences and broad areas of Nanobiotechnology.

#### Unit-II

Nanomaterial in biotechnology - nanoparticles, quantum dots, nanotubes and nanowires etc. Cell - Nanostructure interactions. Protein-based Nanostructures, Cell as Nanobio-machine.

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S. Ash 17/10/2020  
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M. 10/1/2020



DNA-Protein Nanostructures-Overview and introduction, DNA-Protein conjugates in microarray technology.

### Unit-III

Biosensors; molecular recognition elements, transducing elements. Applications of molecular recognition elements in nanosensing of different analytes, Application of various transducing elements as part of nanobiosensors.

### Unit-IV

Miniaturized devices in nanobiotechnology - types and applications, lab on a chip concept. Biological nanoparticles production - plants and microbial, methods, Properties, Characterization and applications.

### Unit-V

Nanobiotechnological applications in health and disease - infectious and chronic. Nanobiotechnological applications in Environment and food - detection and mitigation.

Suggested readings:

1. Nanobiotechnology: Concepts, Applications and Perspectives (2004), Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
2. Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.
3. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.

## 3. Plants for Human Welfare

### Unit-I

A general overview of economically important plants and their role in human welfare as food, oil, drugs, nutraceuticals, fuel. Food crops: Cereals; Spices and condiments; Alcoholic and non-alcoholic beverages.

### Unit-II

Medicinal: Traditional plants as source of drugs against several diseases such as cancer, diabetes, malaria, dengue, psoriasis, etc. Plant secondary metabolites; classification, knowledge of extraction, isolation, characterization and elicitation of bioactive metabolites.

### Unit-III

Nutraceuticals and functional foods; Important plants such as Aloe vera, Piper, Withania, Ginseng, Amaranthus etc. yielding antioxidants and nutraceutical compounds. Edible and non-edible oils: Oil yielding plants, transgenic approaches and constraints for improvement in different oils. Essential oils.

### Unit-IV

Plant-based biofuels e.g., Difference between first and 2nd generation biofuels, Jatropha, Pongamia, Zea mays, Madhuca, etc. Extraction and economic viability; application as alternate source of diesels, Bioelectricity.

### Unit-V

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Plants as a source of timber: e.g., *Tectona grandis*, *Salix* sp., *Dalbergia sisso*, Fibre yielding plants: Cotton (*Gossypium* sp.), Jute (*Corchorus* sp.) with special reference to their improvement through breeding and genetic transformation e.g., Bt cotton.

#### Suggested readings:

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Acharya, Deepak; Anshu, Shrivastava (2008). Indigenous Herbal Medicines: Tribal Formulations and Traditional Herbal Practices. Jaipur, India: Aavishkar Publishers
5. Raven, Peter H.; Evert, Ray F.; Eichhorn, Susan E. (2005). Biology of Plants (7th ed.). New York: W. H. Freeman and Company

### 4. Plant Genetic Engineering

#### Unit-I

Plant transformation vectors and methods: T-DNA and viral vectors; Selectable marker and reporter genes, Plant transformation by *Agrobacterium* sp., Molecular mechanism of T-DNA transfer; in planta transformation; Direct gene transfer methods in plants.

#### Unit-II

Genetic engineering for increasing crop productivity by manipulation of Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency. Genetic engineering for biotic stress tolerance (Insects, fungi, bacteria, viruses, weeds). Genetic engineering for abiotic stress (drought, flooding, salt, metal and temperature)

#### Unit-III

Genetic engineering for quality improvement of Protein, lipids, carbohydrates, vitamins & mineral nutrients, Plants as bioreactor, Marker-assisted selection of qualitative and quantitative traits. Concept of gene synteny, Concept of map-based cloning and their use in transgenics.

#### Unit-IV

Chloroplast transformation; Transgene analysis, silencing and targeting; Marker-free and novel selection strategies; Multigene engineering; Gene knock-down by ribozymes, antisense RNA and RNA interference.

#### Unit-V

Plant Metabolic Engineering. The concept of secondary metabolites, Historical and current views, Importance of secondary metabolites in medicine and agriculture, Introduction to various pathways, Flavanoid pathway, Terpenoid pathway, Polyketoid pathway, Plant vaccine.

#### Suggested readings:

1. Plant Tissue Culture: Theory and Practice Bhojwani S. S. & Razdan M. K. Elsevier
2. Plant Biotechnology: The Genetic Manipulation of Plants Slater A. Scott N. & Fowler M. Oxford University Press Inc.

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3. Plants, Genes and Crop Biotechnology Chrispeels M. J. & Sadava D. E. Jones and Barlett Publishers

4 Principles of Gene Manipulation and Genomics Primrose S. B. & Twyman R. M. Blackwell Publishing.

5. Plant Cell, Tissue and Organ Culture: Fundamental Methods. (Eds). Gamburg O. L & Phillips G. C. Springer-Verlag.

## 5. Evolutionary Biology

### Unit-I

Origin of life: Historical theories and background information, Experimental approaches, Chemogeny, Biogeny, RNA and DNA world, evolution of proteins, origin of photosynthesis, evolution of eukaryotes. Lamarckism, Darwinism, pre-Darwinian and post-Darwinian period, Neo-Darwinism. Theories of organic evolution. Evidences of Evolution.

### Unit- II

Sources of variations: Heritable variations and their role in evolution. Natural selection; types of natural selection (Directional, stabilizing and disruptive) and examples (Industrial melanism, Australian rabbits, resistant to pesticides, heavy metal resistance in plants), Sexual selection, group and kin selection.

### Unit- III

Population genetics and evolution: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon); Role of Migration and Mutation in changing allele frequencies.

### Unit-IV

Evolution above species level: Adaptation, adaptive radiation, microevolution, macroevolution, megaevolution, punctured equilibria and related phenomenon. Isolation: Introduction and types of isolation. Speciation: species concept, modes of speciation: allopatric, sympatric

### Unit-V

Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homo sapiens, Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees.

### Suggested readings:

1. S. Freeman and J. C. Herron, *Evolutionary Analysis*, 4th Edn., Benjamin-Cummings (2007).

2. D. J. Futuyma, *Evolution*, 2nd Edn., Sinauer Associates Inc. (2009)

## 6. Plant-Microbe Interaction

### Unit-I

History of Plant pathology and recent developments: Significance of plant diseases, and pathology, types of plant-microbe associations (pathogenic- bacteria, virus, fungi, and symbiotic).

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## Unit-II

Beneficial Plant - Microbe interactions (molecular aspects): a. Nitrogen fixing bacteria and blue green algae b. Mycorrhizal association c. Phytohormones and Biocontrol antibiotics

## Unit-III

Parasitism and disease development: Pathogenicity, host range of pathogens, disease cycle and epidemics.

## Unit-IV

Molecular biology of pathogenicity: Mechanisms of variability in pathogens, pathogenicity genes and mechanisms in pathogenic bacteria, biotrophic and necrotrophic fungi, Virus and Viroid genes involved in pathogenicity, Agrobacterium and plant interaction-a model system.

## Unit-V

Molecular genetics of plant disease susceptibility and resistance: Types of plant resistance to pathogens (R gene resistance, quantitative and monogenic), basal and induced defense mechanisms, pre-formed inhibitors of pathogens, gene for gene interaction in plant defense, Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR), Recognition mechanism and signal transduction during plant - pathogen interaction.

Suggested readings:

1. Plant Pathology Agrios G. N. Academic Press
2. Molecular Plant pathology Dickinson M. BIOS Scientific Press
3. Plant Pathogenesis and Resistance: Biochemistry and Physiology of Plant-Microbe Interactions Jeng-Sheng H. T Kluwer Academic Pubs. T Gen 904(ii)- MEDICA

## 7. Animal Tissue Culture

### Unit-I

Introduction and significance of Animal cell culture, historical background of cell culture. Types of cell culture: Primary and secondary cell culture.

Laboratory requirements for animal cell culture: Sterile handling area. Sterilization of different materials used in animal cell culture, Aseptic concepts. Instrumentation and equipments for animal cell culture.

### Unit-II

Culture requirements and reagents: Culture media, properties of media, Types of cell culture media, Ingredients of media, Physiochemical properties, Antibiotics, growth supplements, Foetal bovine serum; Serum free media, Trypsin solution, Selection of medium and serum, Conditioned media, Other cell culture reagents, Preparation and sterilization of cell culture media, different types of serum and other reagents.

### Unit-III

Types of cell culture: Different types of cell cultures, Trypsinization, Cell separation, Continuous cell lines, Suspension culture, Organ culture.

Cell lines: Introduction, development of cell lines, Characterization and maintenance of cell lines, stem cells, Cryopreservation, Common cell culture contaminants.

### Unit-IV

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Anitha 17.1.20  
Sandeep 17/10/2020  
Ash 17/11/2020  
Randeep 17/11/20  
17/11/20

**PT. RAVISHANKAR SHUKLA UNIVERSITY**

**Centre for Basic Sciences**

**Syllabus of**

**Integrated M. Sc.: Chemistry Stream**

**[Choice and Credit Based System]**

**Semester Examination  
SESSION 2015-2020**

**Center for Basic Sciences**  
**Pt. Ravishankar Shukla University, Raipur**

Course structure for the M. Sc. (Integrated) Chemistry stream

1<sup>st</sup> July, 2015

(B: **B**iology, C: **C**hemistry, M: **M**athematics, P: **P**hysics, G: **G**eneral, H: **H**umanities,  
 BL: **B**iology **L**aboratory, CL: **C**hemistry **L**aboratory, PL: **P**hysics **L**aboratory,  
 GL: **G**eneral **L**aboratory, PE: **P**hysics **E**lective, PPr: **P**hysics **P**roject)

**FIRST YEAR**  
**SEMESTER – I**

Subject Code	Subject	Contact Hours / Week Theory +Tutorials	Credits
B101	Biology – I	[2 + 1]	3
C101	Chemistry – I	[2 + 1]	3
M100/101	Mathematics – I	[2 + 1]	3
P101	Physics – I	[2 + 1]	3
G101	Computer Basics	[2 + 1]	3
H101	Communication Skills	[2 + 1]	3
		Contact Hours / Week Laboratory	
PL101	Physics Laboratory – I	[4]	2
CL101	Chemistry Laboratory – I	[4]	2
BL101	Biology Laboratory – I	[4]	2
GL101	Computer Laboratory	[4]	2

**26**  
**(26 of 240 credits)**

**C 101: Chemistry-I**  
**UNIT-I**

**(30 + 15 = 45 hrs.)**

**Structure and Properties of atoms: Revisited** **(4 + 2 = 6 hrs.)**

(i) Atomic spectra, Bohr's theory of atomic structure, Sommerfield's theory for complex electron spin and magnetic quantum number, Pauli exclusion principle, Hund's rule, electron configuration of elements, Sequence of energy levels and Periodic Table.

(ii) Size of atoms and ions, ionization energy, electron affinity, electronegativity – values by Pauling, Mulliken and Allred-Rochow, Metallic character, variable valency and oxidation states, horizontal, vertical and diagonal relationships in the periodic table.



(iii) Atomic Nucleus: Fundamental particles, classification of nuclides, nuclear stability, the neutron to proton ratio  $N/Z$ , nuclear potential, binding energy, exchange force. Radioactivity and radioactive elements, radioactive decay and decay kinetics.

## UNIT-II

### Types of Chemical Bonds

(14 + 7 = 18 hrs.)

(i) The covalent bond - the Lewis theory, Octet rule and its limitations. Shapes of the molecules – Sidgwick – Powell theory. Valence shell electron pair (VSEPR) theory, effect of lone pair and electronegativity, isoelectronic principle, examples to apply VSEPR theory. Valence bond theory. Hybridization. Bond length, bond angle & dihedral angle, d-orbital participation in molecular bonding, sigma and pi bonding. Molecular orbital method – Linear combination of atomic orbitals (LCAO), MO treatment for di- and tri-atomic molecules and involving delocalized pi-bonding. Conjugation & aromaticity.

## UNIT-III

(ii) Metallic and organometallic bonds – general properties.

(iii) Coordinate bond- coordination complexes.

(iv) Physical properties and molecular structures – polarizability and dipole moments, melting point, solubility and acid-base properties, Intermolecular forces (dipole-dipole interaction) Hydrogen bonding and van der Waals's forces.

## UNIT-IV

### Reactivity & Mechanism:

(12 + 6 = 18 hrs)

(i) Inductive and field effects and bond dissociation energy.  $p\pi-d\pi$  bonding. Delocalization – cross conjugation, resonance. Aromaticity and Huckel's rule – systems of  $4n$  and  $4n+2$  electrons, antiaromaticity. Resonance and Hyperconjugation.

(ii) Reaction mechanism: Types of mechanisms, Arrhenius theory, collision theory, types of reactions, redox reactions, displacement and addition reactions, thermodynamic and kinetic requirements.

## UNIT-V

Hammond postulate, Curtin-Hammett principle, transition states and intermediates, carbocations, carbanions, free radicals, methods of determining mechanisms, isotopic effects.

(iii) General concepts: Oxidation number and oxidation states, Oxidation – reduction reactions and the use of reduction potential, Bronsted acids and bases, gas phase vs. solution acidity, solvent levelling effects, hardness and softness, surface acidity.

### Suggested texts and References:

- (1) J.D.Lee, Concise Inorganic Chemistry, 4th Edition, ELBS, 1991.
- (2) P.W.Atkins, Physical Chemistry, Oxford University Press, 7th Edition, 2006.
- (3) G.M.Barrow, Physical Chemistry, 5th Edition, Tata McGraw-Hill, New Delhi, 1992.
- (4) R. T. Morrison and R. N. Boyd, Organic Chemistry, Prentice Hall of India.
- (5) G.W. Castellan, Physical Chemistry, 3rd Ed. Addison - Wesley/Narosa Publishing House, 1993.

## CL 101: Chemistry Laboratory

Calibrations of pipette, burette, standard flasks etc., acid base titrations, recrystallization, thin layer chromatography, identification of organic functional groups, complexometric titrations based on EDTA complexation with metals, Synthesis of benzoic acid, diazotization etc.

### Suggested text and references:

- (1) Vogel's Textbook of Quantitative Chemical Analysis (5th Edition; Longmann)
- (2) Vogel's Qualitative Inorganic Analysis (7th Edition)
- (3) ACS Journal of Chemical Education

## SEMESTER –II

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
B201	Biology – II	[2 + 1]	3
C201	Chemistry – II	[2 + 1]	3
M200/201	Mathematics – II	[2 + 1]	3
P201	Physics – II	[2 + 1]	3
G201	Electronics and Instrumentation	[2 + 1]	3
G202	Glimpses of Contemporary Science	[2 + 1]	3
		Contact Hours / Week Laboratory	
PL201	Physics Laboratory – II	[4]	2
CL201	Chemistry Laboratory – II	[4]	2
BL201	Physics Laboratory – II	[4]	2
GL201	Electronics Laboratory	[4]	2

26

(52 of 240 credits)

## C 201: Chemistry II

(30 + 15 = 45 hrs.)

### UNIT-I

(1) Thermochemistry: Enthalpy, heat of fusion and heat of vapourisation, enthalpy of a chemical reaction (heat of combustion, heat of solution, heat of neutralization), enthalpy of formation, standard reaction enthalpy, Hess's law, Kirchhoff's law, bond energy, dissociation energy. Entropy formulation of Second law, entropy change in a phase transition, Trouton's Rule, calculation of absolute (Third law) entropy, entropy change in a chemical reaction.

### UNIT-II

(2) Free energy functions, criteria for spontaneity and equilibrium of closed systems, variation of Gibbs free energy with pressure and temperature, Gibbs Helmholtz equation, the concept of chemical potential, partial molar quantity, Gibbs Duhem relation.

### **UNIT-III**

(3) Phase equilibrium in simple systems: Solid – liquid, liquid – vapour, vapour – solid, phase diagrams – water, carbon dioxide, sulphur, phase equilibrium condition, Gibbs phase rule, Clapeyron equations, Clausius – Clapeyron equation.

### **UNIT-IV**

(4) Ideal Solutions, chemical potential of a solute in a binary ideal solution, Raoult's Law, entropy and Gibbs energy of mixing, Colligative properties – freezing point depression, boiling point elevation, osmotic pressure, van't Hoff equation.

### **UNIT-V**

(5) Chemical equilibrium: Gibbs energy change of a reaction, standard reaction Gibbs energy, the condition for chemical equilibrium, equilibrium constant, reactions involving gases and pure substances, the Principle of Le Chatelier and applications.

(6) Chemical potential of a charged species, electrochemical cell (galvanic and electrolytic), examples of electrochemical cells, half cell potential (electrode potential), Nernst equation.

#### **Suggested texts and References:**

- (1) P.W. Atkins, Physical Chemistry, Oxford University Press, 7th Edition, 2006.
- (2) G.W. Castellan, Physical Chemistry, 3rd Ed. Wesley/Narosa Publishing House, 1993.
- (3) G.N. Lewis and Randall, Thermodynamics, (Revised by K.S. Pitzer and L. Brewer), International Students Edition, McGraw Hill, 1961.
- (4) K. Denbigh, The principles of Chemical Equilibrium.
- (5) B. G. Kyle, Chemical & Process Thermodynamics.

#### **CL 201: Chemistry Laboratory**

Colorimetric titrations, Beer Lambert law, Estimation of concentration by colorimetric methods, conductometric methods, estimation of concentration of acid base by pH meter, identification of inorganic anions and cations, finding of pka values, short project of 2 weeks based on the experiments available in Journal of Chemical Education.

#### **Suggested text and references:**

- (1) Vogel's Textbook of Quantitative Chemical Analysis (5<sup>th</sup> Edition; Longmann)
- (2) Vogel's Qualitative Inorganic Analysis (7<sup>th</sup> Edition)
- (3) ACS Journal of Chemical Education



**SECOND YEAR**  
**SEMESTER –III**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
CB301	Essential mathematics for Chemistry and Biology	[3 + 1]	4
CB302	Biochemistry-I	[3+ 1]	4
CB303	Organic Chemistry-I	[3 + 1]	4
C301	Inorganic Chemistry-I	[3 + 1]	4
H301	World Literature	[2 + 0]	2
H302	History and Philosophy of Science	[2 + 0]	2
		<b>Contact Hours / Week Laboratory</b>	
CL301	Chemistry Laboratory	[6]	3
GL301	Applied Electronics Laboratory	[4]	2

25

(77 of 240 credits)

**CB 303: Organic Chemistry –I**

(45 +15 = 60 hrs.)

**UNIT-I**

**A. Basic concepts - Recapitulation**

Hybridisation, formal charge, inductive and resonance effects and their effect on reactivity and acidity and basicity of organic compounds; polar & non polar covalent bonds; homolytic and heterolytic fission, types of reagents- electrophiles and nucleophiles; curly arrow notation; classification of organic reactions.

**UNIT-II**

**B. Chemistry of Aliphatic compounds**

**IUPAC nomenclature** of aliphatic and substituted aliphatic compounds and alicyclic compounds

**Preparation, structure, properties and reactions of the following classes of compounds.**

i) **Hydrocarbons:** a) **alkanes**, Methods of formation Kolbe reaction, Wurtz reaction, Corey House reaction, decarboxylation of carboxylic acids; Mechanism of halogenation of alkanes, orientation, selectivity & reactivity, product ratio. b) **Cycloalkanes** : Methods of formation and reactivity ; Baeyer's strain theory and its limitation; theory of strainless rings c) **Alkenes:**

Elimination reactions ; Saytzeff & Hoffman elimination; Reactions – halogenation reactions-free radical and polar mechanisms. Markownikoff's rule, the peroxide effect, allylic halogenations using NBS; Ozonides/Ozonolysis. epoxidation; hydroboration-oxidation; oxymercuration-demercuration; Oxidation using  $\text{KMnO}_4$  &  $\text{OsO}_4$ .; polymerization. d) **Dienes:** Structure of butadiene and allene ; 1,2 vs 1,4 addition ; Diels Alder reaction.

### UNIT-III

e) **Alkynes:** Methods of formation; acidity of alkynes; electrophilic addition to alkynes; hydroboration oxidation ; metal ammonia reductions; hydrogenation using Lindlar's catalyst.

ii) **Alkyl halides** Preparation, properties and synthetic applications of alkyl halides;  $\text{S}_{\text{N}}1$  &  $\text{S}_{\text{N}}2$  reactions (mechanism), E1 and E2 reactions( mechanism); Grignard reagent and its applications.

iii) **Alcohols:** Methods of formation; acidity; H-Bonding; reactions of mono; di & trihydric alcohols; Diols as protecting groups.

### UNIT-IV

iv) **Ethers and epoxides:** Formation & reactions of ethers and epoxides ; ring opening reactions of epoxides under acidic and basic conditions; reaction epoxides with Grignard & organolithium reagents

v) **Aldehydes & ketones:** Methods of formation of aldehydes and ketones; Nucleophilic addition reactions with cyanide, ammonia and derivatives of ammonia; acetal formation; oxidation reduction reactions. Meerwin-Ponndorf-Verley reduction, Clemmensen reduction, Wolf-Kishner reduction, Aldol condensation reaction, Cannizzaro reaction, Tischenko reaction, haloform reaction, Baeyer-Villiger oxidation, Wittig reaction; Mannich reaction

vi) **Carboxylic acids** : Methods of formation of mono and di carboxylic acids; acidity and factors affecting acidity; reactions of carboxylic acids :

vii) Carboxylic acid derivatives: Methods of formation of acid chlorides, amides, anhydrides and esters and their interconversions; relative stabilities of acid derivatives; Rosenmund reaction; Hoffmann rearrangement; saponification.

viii) Nitrogen and sulphur compounds. a) Nitro alkanes: methods of formation and reactions of aliphatic and aromatic nitro compounds b) Amines: methods of formation; basicity and factors affecting basicity ; reactions of aliphatic amines. c) Sulfonic acids : Methods of formation & reactions of aliphatic sulfonic acids.

ix) Applications of phosphorous and boron in organic synthesis :

Wittig reaction (with mechanism) ; hydroboration-oxidation (with mechanism); reduction using 9-BBN.

### UNIT-V

#### C. Chemistry of aromatic compounds

IUPAC Nomenclature of benzene, naphthalene and anthracene derivatives

i) Aromaticity: Structure and stability of benzene, Huckel's rule, MO picture, polycyclic aromatic hydrocarbons.

ii) Aromatic electrophilic substitution: General mechanism. Effect of substituents on rate and orientation to aromatic electrophilic substitution in substituted benzenes, ortho-para ratio.

iii) Hydrocarbons: Alkylarenes, preparation via Friedel Crafts reaction. Reactions- oxidation, nuclear and side chain halogenation.

- iv) Haloarenes: Preparation, aromatic nucleophilic substitution, elimination-addition and addition-elimination mechanisms, hydrolysis and amination of nitrohaloarenes.
- v) Phenols: Preparation from sulfonic acids, haloarenes, alkylbenzenes, Acidity, O-alkylation, O-acylation, Fries rearrangement, Claisen rearrangement, Reimer-Tiemann reaction, Hauben Hoesch reaction, Lederer Manasse reaction.
- vi) Aromatic aldehydes and ketones: Preparation via Gattermann, Gattermann-Koch, Vilsmeier-Haack, Rosenmund and Friedel Crafts acylation reactions, Reactions: Claisen-Schmidt, Knoevenagel, Perkin, Benzoin condensation and Cannizzaro reactions,
- vii) Aromatic carboxylic acids: Preparation, acidity, preparation and interconversion of acid derivatives.
- viii) Aromatic sulfonic acids: Preparation, acidity, preparation and interconversion of sulfonic acid derivatives.
- ix) Aromatic nitrogen compounds: Nitro and nitroso compounds - preparation and reduction, Amino compounds – preparation, basicity, Aromatic electrophilic substitution, N-alkylation, N-acylation, Diazotisation, Synthetic uses of diazonium salts, azo coupling

### **Suggested texts and References:**

- (1) I. L. Finar, Organic Chemistry, Vol. 1 & 2, ELBS.
- (2) R. T. Morrison and R. N. Boyd, Organic Chemistry, Prentice Hall of India.
- (3) J. McMurry, Organic Chemistry, Asian Books Pvt. Ptd.
- (4) L. G. Wade, Organic Chemistry, Pearson Education
- (5) G. Solomons and C. Fryhle, Organic Chemistry, John Wiley & Sons (Asia) Pte Ltd.
- (6) J. March, Advanced Organic Chemistry, 3rd Edn. McGraw Hill, 1991.
- (7) S.H. Pine, Organic Chemistry, 5th Edn., McGraw Hill, 1987.

## **C 301: Inorganic Chemistry I**

### **UNIT-I**

**(45 + 15 = 60 hrs.)**

- (i) **Hydrogen:** Preparation of hydrogen, Isotopes, ortho and para hydrogen, hydrides.
- (ii) **Rare gases:** Occurrence and recovery of the elements, physical and chemical properties, Clathrate compounds, chemistry of Xenon and xenon fluoride complexes.

### **UNIT-II**

- (iii) Chemistry of s-block elements: a) alkali and alkaline earth metals: Extraction, general physical properties, flame colours and spectra, Reaction with water, air and nitrogen, oxides, hydroxides, peroxides and superoxides, sulphides, oxysalts, halides and hydrides, organo and organometallic compounds. b) Group IIB elements: Zn, Cd, Hg.

### **UNIT-III**

- (iv) Chemistry of p-block elements: a) Group IIIA elements: Boron, aluminium, gallium indium and thalium – physical properties, oxidation states and type of bonds, Reactions with other elements, compounds of boron with oxygen and hydrogen. b) Group IVA elements: carbon, silicon, germanium, tin and lead – physical properties, allotropes of carbon, graphite compounds, carbides, carbonates, carbon cycle, silicates, organosilicons, hydrides, halides and cyanides, cluster compounds.



#### UNIT-IV

c) Group VA elements: Nitrogen, phosphorous, Arsenic, antimony and bismuth – general properties, hydrides, azides, oxides and oxyacids, sulphides and organometallics, fertilizers. d) Group VIA elements: oxygen, sulphur, selenium, tellurium and polonium – general properties, structure and allotropy of the elements, chemistry of ozone, oxides, oxyacids, oxohalides, hydrides and halides, organo derivatives.

#### UNIT-V

e) Group VIIA elements: Fluorine, chlorine, bromine, iodine and Astatine- general properties, oxidizing power, hydrogen halides, ionic and molecular halides, bridging halides, halogen oxides, oxoacids, interhalogen compounds, polyhalides, pseudohalogens and pseudohalides.

#### Suggested texts and References:

- (1) J. E. Huheey, 'Inorganic Chemistry - Principles of Structure and Reactivity' Harper & Row, 1988.
- (2) F. A. Cotton and G. Wilkinson, 'Advanced Inorganic Chemistry', John Wiley, 1995.
- (3) D. F. Shriver, P.W. Atkins and C.H. Langford, 'Inorganic Chemistry', Oxford University Press, 1991.
- (4) F. A. Cotton and G. Wilkinson, Basic Inorganic Chemistry, Wiley Eastern, 1978.
- (5) J. D. Lee, Concise Inorganic Chemistry, Van Nostrand Reinhold, 1977.

CL 301: Chemistry Laboratory

Experiments of inorganic chemistry: Synthesis of coordination complexes, gravimetric analysis etc

### SEMESTER –IV

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
PCB401	Physical and Chemical kinetics	[3 + 1]	4
CB401	Introductory Spectroscopy (UV-vis, fluorescence, IR, Raman, NMR)	[3+ 1]	4
C401	Properties of Matter	[3 + 1]	4
C402	Group theory	[3 + 1]	4
G401	Statistical Techniques and Applications	[2 + 0]	2
		<b>Lab hrs</b>	<b>Credits</b>
CL401	Chemistry Laboratory	[6]	3
GL401	Computational Laboratory and Numerical Methods	[4]	2

25

(102 of 240 credits)

**PCB 401: Physical and Chemical Kinetics:****(45 + 15 = 60 hrs.)****UNIT-I**

**(i) Basic Concepts:** Rate, order and molecularity of a reaction, First, second and third order reactions – effect of concentration on reaction rate, rate expressions and integrated form, pseudo-unimolecular and second order autocatalytic reactions, nth order reaction of a single component, effect of temperature on reaction rate – Arrhenius equation and activation energy.

**UNIT-II**

**(ii) Complex Reactions:** parallel first order reactions, series first order reactions – determination of rate constants by graphical method and the time ratio method. The stationary state, radioactive decay, general first order series and parallel reactions. Competitive, consecutive second order reactions, reversible reactions, equilibrium from the kinetic view point, complex mechanisms involving equilibria.

**UNIT-III**

**(iii) Kinetic Measurements:** Experimental determination of reaction rates and order of reactions – correlation of physical properties with concentrations, reactions in the phase, reactions at constant pressure, fractional-life period method, initial rate as a function of initial concentrations.

**UNIT-IV**

**(iv) Reactions in Solutions:** General Properties, Phenomenological theory of reaction rates, Diffusion limited rate constant, Slow reactions, Effect of ionic strength on reactions between ions, Linear free energy relationships, Relaxation methods for fast reactions.

**UNIT-V**

**(v) Catalysis:** Homogeneous catalysis in gas phase, in solution, basis of catalytic action, catalysis and the equilibrium constant, acid base catalysis, The Bronsted catalysis law, linear free energy changes, general and specific catalysis. Heterogeneous catalysis. Negative catalysis and inhibition, Surface reactions – effect of temperature and nature of surface. Industrial catalysis.

**Suggested texts and References:**

- (i)** K.A. Connors, Chemical Kinetics : A Study of Reaction Rates in Solution, V.C.H. Publications 1990. **(ii)** J.I. Steinfeld, J.S. Francisco and W.L. Hase, Chemical Kinetics and Dynamics, Prentice Hall 1989. **(iii)** Paul L. Houston, Chemical Kinetics and reaction dynamics. **(iv)** K.J.Laidler, Chemical Kinetics, 3rd ed. Harper and Row, 1987. **(v)** J.W. Moore and R.G. Pearson, Kinetics and Mechanisms, John Wiley and Sons, 1981. **(vi)** A. A. Forst and R. G. Pearson, Kinetics and Mechanism, Wiley International Edition. **(vii)** Sanjay K. Upadhay, Chemical kinetics and Reaction Dynamics, Springer, 2006

**CB401: Introductory Spectroscopy****(45 + 15 = 60 hrs)****UNIT-I**

**(i) The electromagnetic spectrum:** Nature of electromagnetic radiation. The electromagnetic spectrum and its regions. Frequency, waveno and wavelength: units and conversions. Absorption of electromagnetic radiation. Molecular energy states and quantisation of internal energy. Boltzmann distribution.

**(ii) Spectroscopic Processes:** Absorption, emission, and scattering of light. Beer-Lambert Law - Quantitative absorption measurements, Jablonski diagram

**(iii) Fourier transformation:** A mathematical tool to our advantage, basic principle and its relevance in spectroscopy.

## UNIT-II

**(iv) UV-VIS Absorption Spectroscopy:** Principles and instrumentation of spectrophotometers. UV-vis spectroscopy to determine conjugation. UV-visible spectroscopy and electronic transitions. Electronic ground states and excited states in organic molecules: n to pi-star and pi to pi-star transitions. band position and band intensities.

**(v) Fluorescence Spectroscopy:** Principles and instrumentation of fluorimeters. Advantage of fluorimetry compared to absorption spectrophotometry. Luminescence and the fate of excited states: timescale of fluorescence and phosphorescence. Qualitative and Quantitative Fluorimetry.

## UNIT-III

**(vi) IR -** Principles and instrumentation of Infrared spectroscopy. Infrared spectroscopy and molecular vibrational transitions. Simple dispersive IR spectrometer and overview of modern instrumentation. Transmittance and absorbance. Vibrational modes and selection rules. Factors governing the position and intensity of IR bands: effects of variation in reduced mass and force constant. Group frequency and fingerprint regions: use of IR for identification by presence/absence of absorptions characteristic of specific bonds/bond groupings. Interpretation of IR spectra.

**(vii) Raman Spectroscopy:** Raman Effect and molecular polarizability. Technique and instrumentation. Pure rotational Raman spectra, vibrational Raman spectra. Structure determination from Raman and IR.

## UNIT-IV

**(viii) Nuclear Magnetic Resonance (NMR):** Introduction to Nuclear Magnetic Resonance (NMR) spectroscopy. <sup>1</sup>H and <sup>13</sup>C NMR, number of signals, integration, chemical shift, splitting of signals. Principles and instrumentation of NMR spectroscopy. Nuclear spin and nuclear magnetism. Energies of nuclear spin states in a magnetic field. Boltzmann population of nuclear spin states and the origin of NMR signals. Applications: Interpretation of simple <sup>1</sup>H NMR spectra. Information from: chemical shifts and delta values, peak areas and integration, splitting patterns and spin-spin coupling constants. (n+1) rule and Pascal's triangle. <sup>13</sup>C NMR spectra and sensitivity issues. Interpretation of NMR spectra using examples of organic compounds. Short introduction about application of NMR for proteins.

## UNIT-V

**(ix) Mass spectrometry:** Introduction to mass spectroscopy (molecular mass, accurate mass and isotopes) Principles, ionisation methods (including EI, MALDI, ESI). Molecular ions and fragmentation processes under EI. Mass spectrometry for determining the molecular weight/formula of organic compounds and identify the presence of isotopes. Introduction of MS application in protein analysis.



## **C 401: Properties of Matter**

**(45 + 15 = 60 hrs.)**

### **UNIT-I**

**(i) Gaseous State** a). Perfect gases and gas laws, law of partial pressures and partial volumes, Graham's law of effusion, critical state and determination of the critical constants, continuity of state, coefficient of expansion and compressibility. b). The kinetic theory of gases, pressure and temperature of a gas, derivation of the gas laws from the kinetic theory, The Boltzmann constant, Maxwell's law of distribution of molecular velocities, experimental verification of Maxwell's law. c). Ideal and real gases, deviations of the real gases from the ideal gas laws, collision diameter, van der Waals equation, reduced equation of state, The Dieterici equation, The Berthelot's equation, The equation of Kammerling-Onnes, Virial Theorem and equation of state, compressibility factors, The heat capacity of gases, The principle of equipartition of energy, gas density and vapour density. d). Collision number and mean free path, transport properties: viscosity, thermal conductivity and diffusivity of gases.

### **UNIT-II**

**(ii) The Liquid State:** a) Intermolecular forces – dipole-dipole London forces, hydrogen bonding. b) Vapour pressure, determination of vapour pressure, external and internal pressure, boiling point and vapour pressure. c) Surface tension, angle of contact and wetting of surface pressure on a curved surface, rise of liquid in a capillary tube, measurement of surface tension. Surface tension and vapour pressure, surface tension and temperature – Eotvos-Ramsay-Shields relation, Macleod's equation, parachor. d) Viscosity, measurement of relative and absolute viscosity, viscosity and temperature, molecular weight from viscosity. e) refractive index, specific rotation, molar refraction and chemical constitution, optical activity and specific rotation.

### **UNIT-III**

**(iii) The Solid State:** Crystalline and amorphous solids, Crystals – Steno's law, Hauy's law, Laws of symmetry. Crystals systems and lattices, Crystals and X-rays, Bragg's method of crystal analysis. Different kinds of crystal structures, methods of crystal analysis, electron diffraction, Isomorphism, Heat capacity of solids, Debye's equation. Liquid crystals, magnetic properties - diamagnetic and paramagnetic materials. Ionic, covalent, metallic and coordinate bonds. (ii) Ionic Bond - characteristics of ionic compounds and crystal structures, radius ratio rules and coordination number, close packing. Classification of ionic structures – AX, AX<sub>2</sub> and AX<sub>3</sub> groups. Lattice Energy, Stoichiometric defects – Schottky and Frenkel. Non-stoichiometric defects – metal excess and metal deficiency. Semiconductors and transistors.

### **UNIT-IV**

**(iv) Colloids:** The colloidal system, preparation of colloidal systems, classification. Lyophobic sols - optical and electrical properties, effect of addition of electrolytes and applied electric field. Determination of zeta potential by electrophoresis and electroosmotic methods. Origin of charge and the mechanism of flocculation – stability of sols. Properties of Lyophilic sols – viscosity and protective action.

### **UNIT-V**

Kinetic properties of sols and Brownian motion. Determination of Avogadro's number from vertical distribution of sol particles and by diffusion method. Macromolecules – viscosity and

molecular weight of polymers, osmotic pressure, The Donnan equilibrium. Sedimentation and ultracentrifuge, scattering of light. Protein sols, association colloids and emulsions, Ideal solution and colligative properties.

### **Suggested texts and References:**

- (1) P.W. Atkins, Physical Chemistry, Oxford University Press, 7th Edition, 2006.
- (2) G.M. Barrow, Physical Chemistry, 5th Edition, Tata McGraw-Hill, New Delhi, 1992.
- (3) D.A. McQuarrie and J.D. Simon, Physical Chemistry - a molecular approach, Viva Books Pvt. Ltd. (1998).
- (4) D.K. Chakrabarty, Adsorption and catalysis by solids, Wiley Eastern, 1990.
- (5) F.P. Kane and G.B. Larrabee (Eds.), Characterisation of solid surfaces, Plenum, 1978.
- (6) A.W. Adamson, Physical Chemistry of Surfaces, 3rd Edn., Wiley Interscience, 1976.

**C 402: Group theory**

**(45 + 15 = 60 hrs)**

### **UNIT-I**

(i) Symmetry Elements and Operations, Pure Rotations ( $C_n$  Rotations), Improper Rotations, Rotation-Reflection ( $S_n$ ) & Rotation-Inversion ( $\bar{n}$ ) Axes.

### **UNIT-II**

(ii) Point Groups: Low Symmetry Point Groups ( $C_1$ ,  $C_i$ ,  $C_s$ ), Simple Axial Point groups ( $C_n$ ,  $S_{4n}$ ,  $C_{nv}$ ,  $C_{nh}$ ), Dihedral Groups ( $D_n$ ,  $D_{2n}$ ,  $D_{nh}$ )

### **UNIT-III**

Platonic Solids & the "Cubic" Groups ( $T_d$ ,  $O_h$ ,  $I_h$ ), Derived High Symmetry Groups ( $T$ ,  $T_h$ ,  $O$ ,  $I$ ), The "Infinite Groups" ( $C_{\infty v}$  and  $D_{\infty h}$ ), Point Groups & Chirality, Point Groups & Dipole Moment.

### **UNIT-IV**

(iii) Multiplication Tables (i.e., operation 1 followed by operation 2) for point groups. Similarity Transforms, Classes of Symmetry Elements. Naming Representations (Mulliken Symbols), Subgroups and Supergroups., Non Commutative Operations.

### **UNIT-V**

(iv) Representations of Groups., Irreducible Representations., Character Tables. Their derivations and use of their contents. Matrix Representation of Symmetry Operations. The "Full Form" of the Character Table.

### **Suggested texts and References:**

1. F. A. Cotton, "Chemical Applications of Group Theory", 3rd Edition, John Wiley (1990).
- G 401: statistical techniques and its applications

**CL 401: Chemistry Laboratory**

Acetylation of primary amine, synthesis of cyclohexanone oximes, nitration of phenols, bromination of acetanilide, photoreduction of benzophenone to benzopinacole, pinacole pinacolone rearrangements, benzil- benzilic acid rearrangement, aldol condensation, coenzyme catalysed benzoin condensation, separation of organic mixtures( solid-solid, solid -liquid and liquid-liquid), characterization of all the synthesized compounds using FTIR, UV-vis spectroscopy and <sup>1</sup>H-NMR.

**3<sup>rd</sup> Year**  
**SEMESTER –V**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
CB501	Analytical Chemistry	[3 + 1]	4
C501	Quantum Chemistry	[3+ 1]	4
C502	Inorganic Chemistry II	[3 + 1]	4
C503	Organic Chemistry II	[3 + 1]	4
G501	Earth Science and Energy & Environmental Sciences	[3 + 1]	4
		<b>Lab contact hrs</b>	<b>Credits</b>
CL501	Chemistry Laboratory	[8]	4

**24**

**(126 of 240 credits)**

**CB 501: Analytical Chemistry**

**(45 + 15 = 60 hrs.)**

**UNIT-I**

**(i) Error analysis:** Methods of sampling and associated errors, Classification of errors, Propagation of errors, treatment of errors, Normal distribution, Tests of Significance and Confidence Limits.

**UNIT-II**

**(ii) Separation techniques:** Solvent Extraction Technique: Conventional, Liquid Membranes – Bulk, Supported and Emulsified, Solid Phase Extraction (SPE). Ion Exchange: Conventional, Membranes. Chromatography: Gas chromatography (GC), High Performance Liquid Chromatography (HPLC), Ion chromatography (IC).

**UNIT-III**

**(iii) Mass Spectrometry:** Mass Analysers – Magnetic, Quadrupole, Time of Flight (TOF), Features – Resolution, Dispersion, Abundance, Sensitivity, Detectors, Ion Sources –Thermal Ionisation (TI), Electron Impact, ICP, GD, Laser Ablation (LA-ICP), Secondary Ionisation (SI),



Matrix Assisted Laser Desorption and Ionisation (MALDI), Hyphenated Technique – IC-MS, HPLC-MS, GC-MS.

#### UNIT-IV

**(iv) Thermal Methods:** Thermogravimetric Analysis (TGA), Derivative Thermogravimetric Analysis (DTG), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Evolved Gas Analysis (EGA).

**(v) Electrochemical Methods:** Introduction, Potentiometry, Ion Selective Electrodes (ISE), Voltammetry & Polarography, Cyclic, Pulse and Stripping Voltammetry, Coulometry and Amperometry, AC Electrochemical Techniques, Scanning Electrochemical Microscopy.

**(vi) Detectors-** Photomultiplier Tube (PMT), Charge Coupled Device (CCD), Charge Injection Device (CID), Spectrometers – Czerny Turner, Echelle, Sample Introduction Devices – Flame, Electrothermal, Laser Ablation, Direct Sample Insertion Devices, Interferences, detection limits, sensitivity.

#### UNIT-V

**(vii) Conductance of solutions and electrochemistry:** Faraday's laws of electrolysis, Electrolytic conduction- Arrhenius theory of electrolytic dissociation, strong and weak electrolytes. Migration of ions – transference numbers, Determination of transference number using Hittrof's rule and moving boundary method. Conductance of solutions – electrolytic conductance, determination of conductance, equivalent conductance and concentration, Kohlrausch's law of independent migration of ions, ionic mobilities, temperature dependence. Hydration of ions, the interionic attraction theory. Applications of conductance measurements– degree of dissociation of weak electrolytes, dissociation constants of weak acids, degree of dissociation of water, basicity of organic acids, determination of solubilities of sparingly soluble salts, conductometric titrations, activities of electrolytic solutions, ionic strength. The Debye-Huckel theory of dilute ionic solutions.

#### Suggested texts and References:

- (1) D.A. Skoog, D. M. West, F. J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, 8th Edition, Thomson (2004).
- (2) A.I. Vogel, A text book of Quantitative Analysis, 5th Edition Revised by G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, ELBS (1989).
- (3) A. K. De, S. M. Khopkar and R. A. Chalmers, Solvent Extraction of Metals, Van Nostrand, Reinhold (1970).
- (4) L. R. Snyder and J. J. Kirkland, Introduction to Modern Liquid Chromatography, 2nd Edition, Wiley (1979).
- (5) Jose A. C. Broekaert, Analytical Atomic Spectrometry with flames and Plasmas, Wiley-VCH (2002).
- (6) John Roboz, Introduction to Mass Spectrometry: Instrumentation and Techniques, Interscience (1968).

**C 501: Quantum Chemistry****(45 + 15 = 60 hrs.)****UNIT-I**

- (i) Foundations of quantum mechanics.
- (ii) Wave function for a free particle, the Schrodinger equation, physical interpretation of the Scrodinger equation wave function, expectation of a dynamical quantity, Wavepackets and the uncertainty principle, WKB approximation.

**UNIT-II**

- (iii) Operator concept in quantum chemistry.
- (iv) Solution of Schrodinger's equation in some simple systems: one and three dimensional boxes, electron in a ring, rigid rotator, concept of tunnelling, one dimensional harmonic oscillator, hydrogen-like atoms, shapes of atomic orbitals.

**UNIT-III**

- (v) Approximate methods of quantum chemistry: variational principle; Time-independent perturbation theory: Many electron ssysytems: Orbital approximation, Slater determinant; Hartree-Fock self-consistent field theory; Slater type orbitals.

**UNIT-IV**

Concept of LCAO and introduction to ab-initio and semi-empirical molecular orbital calculations of molecules. Huckel Theory: Extended systems: From bonds to bands. Angular momentum of many-particle systems. Born-Oppenheimer approximation, MO and VB theories illustrated with H<sub>2</sub>-molecule, An elementary treatment of scattering theory.

**UNIT-V**

- (vi) Spin orbital interaction; LS and JJ coupling. Spectroscopic term symbols for atoms. Molecules and Chemical bonding, Spectroscopic term symbols for diatomics; Directed valence & hybridization in simple polyatomic molecules.

**Suggested texts and References:**

- (1) Ira N. Levine, Quantum Chemistry Prentice Hall India.
- (2) John L. Powell and Bernd Crasemann, Quantum Mechanics, Oxford & IBH Publishing.
- (3) A. K. Chandra, Introductory Quantum Chemistry, Tata McGraw-Hill Publishing Comp. Ltd.
- (4) David B. Beard, Quantum Mechanics, Allyn & Bacon, Inc, Boston.

**C 502: Inorganic Chemistry II:****(45 + 15 = 60 hrs.)****UNIT-I**

- (i) Coordination compounds, Werners's theory, effective atomic number, coordination number, shapes of d-orbitals and bonding in transition metal complexes, stability of complexes, the chelates and macrocyclic effects, types of classification of ligands, second sphere of coordination,  $\pi$ -complexes,  $\pi$ -acid ligands, multiple bonds from ligands to metals.

## UNIT-II

(ii) Crystal Field theory – crystal field splitting and elementary treatment of the electronic spectra, Jahn-Teller distortion of octahedral complexes, square planar complexes, tetrahedral complexes, magnetic properties of 3d compounds.

## UNIT-III

(iii) MO theory – Nomenclature of coordination compounds, d-orbital splitting in various fields - Spectroscopic states - Tanabe-Sugano and Orgel diagrams - Derivation of Ligand field parameters (Dq, B) from electronic spectra - Magnetic moments - Orbital contribution, spin-orbit coupling and covalency.

## UNIT-IV

Molecular orbitals and energy level diagrams for common symmetries.

(iv) Bonding involving-donor ligands - Back-bonding - f-orbital splitting - Spectral and magnetic properties of f-block elements.

## UNIT-V

(v) Reaction mechanisms: Substitution reactions - Dissociative and associative interchange - trans-effect - Linear free energy relations. Rearrangements - Berry pseudo rotation, Electron transfer reactions. Photo-dissociation, substitution and redox reactions, Fluxional molecules.

### Suggested texts and References:

- (1) F.A. Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann, *Advanced Inorganic Chemistry*, Wiley Eastern, John Wiley, 6th Ed., 1999.
- (2) J.E. Huheey, E. Keiter and R. Keiter, *Inorganic Chemistry*, 4th Ed., Harper Collins College Publisher, 1993.
- (3) D.Banerjee, *Inorganic Chemistry Principles*, Books Syndicate Pvt. Ltd., 2000.
- (4) N.N. Greenwood and E.A. Earnshaw, *Chemistry of Elements*, Pergamon Press, 1989.
- (5) J.J. Kratz, G.T. Seaborg and L.R. Morss; *The Chemistry of Actinide Elements*, 2nd Edition, Vol. 1&2, Chapman & Hall, New York (1986).
- (6) J.C. Bailar, H.J. Emelius, R. Nyholm and A.F. Trotman-Dickenson; *Comprehensive*

## C 503: Organic Chemistry – II

(45 + 15 = 60 Hrs.)

### UNIT-I

(A) **Stereochemistry of Organic Compounds** 25h (i) Isomerism – Concept and types (ii) Chirality: Configuration, stereogenic/chiral center, chirality and enantiomerism. Representation of configuration by flying wedge formulae and Fischer, Newman and Sawhorse projection formulae. (iii) Stereochemistry of carbon compounds with upto three similar and dissimilar asymmetric carbon atoms; enantiomers, diastereomers, and racemic mixtures and their properties, resolution (chemical and chromatographic). (iv) Diastereomerism: Threo, erythro, meso diastereomers. Geometrical isomerism in olefins, cycloalkanes and oximes. Absolute



configuration: Assigning of stereochemical descriptors - R/S to Fischer projection and flying wedge formulae of chiral molecules and E/Z to olefins.

#### UNIT-II

(v) Molecular chirality and elements of symmetry: Stereochemistry and stereochemical nomenclature of biphenyls, spirans, cummulenes, and alkylidene cycloalkanes (vi) Conformational concepts, conformations of acyclic molecules (ethane and butane), cyclohexane and mono, di-substituted cyclohexanes. Conformationally rigid and mobile diastereomers. (vii) Stereoselectivity and stereospecificity of organic reactions: Enantiomeric and diastereomeric selectivities.

#### UNIT-III

The mechanism and stereochemical outcome of the following reactions: (a) S<sub>N</sub>1, S<sub>N</sub>2 and S<sub>N</sub>i reactions (b) Catalytic hydrogenation of alkenes (c) Ionic trans addition of bromine to alkenes (d) Epoxidation of alkenes, acid catalysed ring opening of epoxides. (e) Reactions of OsO<sub>4</sub> and KMnO<sub>4</sub> with olefins (f) E2 reactions. (g) Topicity and prostereoisomerism - Enantiotopic and diastereotopic atoms, groups and faces.

#### UNIT-IV

##### (B) Chemistry of heterocyclic compounds

25h

Heterocycles containing one heteroatom (furan, thiophene, pyrrole, pyridine) and more than one heteroatom (pyrazole, imidazole, oxazole, thiazole, pyrimidine and pyrazines) their derivatives – preparation, properties and reactions. (C) **Chemistry of Alicyclic compounds:** Cycloalkanes and cycloalkenes. Factors affecting stability of conformations, conformation of cycloalkanes. Reaction mechanism in alicyclic compound.

#### UNIT-V

(i) Conformation of Cyclic System: Monocyclic compounds and Fused ring and Bridged ring Compound. Topicity and Prostereoisomerism & Racemisation and Methods of Resolution.

(ii) Dynamic stereochemistry: Conformationally rigid and mobile diastereomers, stereoselectivity.

(iii) Chemistry of Carbon radical (Single electron transfer mechanism): neighboring group participation; non-classical carbocation; S<sub>N</sub>i mechanism. Rearrangements of Carbocation, Free-radical: Allylic, Pinacol/ Pinacolone, 1,2 rearrangements etc and rearrangement to heteroatoms. Pericyclic reaction and FMO approach.

#### Suggested texts and References:

- (1) I. L. Finar, Organic Chemistry, Vol. 1 & 2, ELBS.
- (2) R. K. Bansal, Heterocyclic Chemistry, Synthesis, Reactions and Mechanisms, Wiley Eastern Ltd., 1990.
- (3) J.A.J. Joule and G.F. Smith, Heterocyclic Chemistry, ELBS, 2nd Ed., 1982. F.G. Riddell, The Conformational Analysis of Heterocyclic Compounds, Academic Press, 1980.
- (4) L.A. Paquette, Principles of Modern Heterocyclic Chemistry, W.B. Benjamin, Inc., 1978.
- (5) B.M. Acheson, An Introduction to the Chemistry of Heterocyclic Compounds, Interscience, 2nd Ed., 1975.

## **G501: Earth Science and Energy & Environmental Sciences**

### **Earth Science**

Origin of the earth, type of rocks in different layers, their physical and chemical properties, mechanism of their formation and destruction. Radioactivity and its role in geochronology, Plate tectonics and geodynamics and the role of mantle plumes in sustaining these processes. Gravity, electrical and magnetic properties of the different layers in the earth. Their variations in different geological terrains. Instrumentation, field procedures used in these studies. Response of the earth to the elastic (Seismic) and electromagnetic waves, use of this phenomena to study the earth's interior. Geodynamo and the internal magnetic field of the earth. Paleomagnetic studies, Polar wandering and reversal, possible theoretical arguments for understanding the phenomena. Seismology and its use in understanding of the different layers in the earth's interior. Utility of the different geophysical techniques (discussed above) in exploration for academic as well as for harnessing resources.

### **Suggested Texts and references:**

1. The magnetic field of the Earth, Merrill, R.T. McElhinny, M.W. and McFadden, P.L. International Geophysical Series.
2. Earth Science by Edward J. Tarbuck, E.J. and Lutgens, F.K.
3. Introduction to Applied Geophysics: Exploring the Shallow Subsurface Burger, H.R., Sheehan, A.F., C.H.
4. Mantle Plumes and Their Record in Earth History, Condie, K.C., 2001, Cambridge University Press, Cambridge, UK
5. Applied Geophysics (Paperback) W M Telford, Robert E Sheriff and L P Geldart.

### **Energy and Environmental Sciences**

Introduction to Environmental Science. Natural Environments: Ecosystems and ecology, biodiversity. Socio-cultural environments: demography, population density, human organizations. Land use and its planning. Global climate change and effects on environment. Carbon cycle from human activity, calculation of carbon budgets. Water harvesting, storage and treatment. Natural calamities, hazards, and effects of human activity: Chemical and other technological hazards. Various case studies of natural calamities and human-induced disasters. Causes, effects, forecasting, preparedness, planning measures, technological solutions, social interventions. Concept of sustainability, individual and social, and local and global actions for a sustainable future. Introduction to energy Sources - evolution of energy sources with time. Power production, per capita consumption in the world, and relation to development index. Energy scenario in India: Various issues related to consumption and demands -energy crisis issues in India. Renewable and non-renewable energy sources - technology and commercialization of energy sources, local (decentralized) versus centralized energy production, constraints and opportunities of renewable energy (hydrocarbon and coal based energy sources). Energy conservation – calculation of energy requirements for typical and home and industrial applications. Alternative to fossil fuels - solar, wind, tidal, geothermal. Bio-based fuels. Hydrogen as a fuel. Energy transport and storages, comparison of energy sources - passage from source to delivery (source, production, transport, delivery) - efficiencies, losses and wastes. Nuclear energy: Power production: Components of a reactor and its working, types of reactors and comparison. India's three stage nuclear program. Nuclear fuel cycle. Thorium based reactors. Regulations on nuclear energy.

**Suggested texts and References:**

1. Energy in Perspective, J.B.Marion, University of Maryland, Academic Press, (1974)
2. Energy and Environment, Robert A.Ristinen and Jack J. Kraushaar, 2nd Edn., John Wiley and Sons, Inc. (2006).
3. Renewable Energy, Boyle Godfrey, Oxford University Press (2004)
4. Environment, Problems and Solutions, D.K.Asthana and Meera Asthana, S.Chand and Co.(2006)
5. Text Book on Environmental Chemistry, Balaram Pani, I.K.International Publishing House(2007).

**CL 501 Chemistry Laboratory:**

Isolation and purification of lysozyme protein from hen egg by different methods (ethanol, ammonium sulfate and TCA precipitation), Relative quantification of lysozyme obtained from different methods by using: Dialysis, Gel electrophoresis, UV-Vis spectroscopy, Purification of lysozyme obtained from different methods with fast performance liquid chromatography (FPLC), Qualitative analysis of the lysozyme obtained after FPLC by using spectroscopic techniques (UV-Vis and fluorescence spectroscopy), Calculation of Quantum yield using fluorescence Spectroscopy, Binding effect of ligand on fluorescence of protein fluorophore (Calculation of inner filter effect), Calculation of binding constant of a ligand with protein by Stern-Volmer plot using fluorescence spectroscopy, Study of solvent effects on the stability of proteins by drawing a denaturation profile in presence of denaturing agents using UV-Vis and fluorescence spectroscopy.

**SEMESTER –VI**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
CB601	Biophysical Chemistry	[3 + 1]	4
C601	Atomic and molecular spectroscopy	[3+ 1]	4
C602	Inorganic Chemistry III	[3 + 1]	4
C603	Organic Chemistry III	[3 + 1]	4
C604	Nuclear Chemistry	[3 + 1]	4
H601	Ethics in Science and IPR	[2 + 0]	2
		<b>Lab contact hrs</b>	<b>Credits</b>
CL601	Chemistry Laboratory	[6]	3

**25****(151 of 240 credits)****CB 601: Biophysical Chemistry****UNIT-I**

**(i) The Chemistry of Life: An introduction:** Physical properties of water: Structure, water as solvent, The hydrophobic effect, osmosis and diffusion. Introduction to Biomolecules: Nucleic



Acid, Protein - Polymer Description of Macromolecular Structure, Intermolecular and Intramolecular forces, Non Covalent Interaction

#### **UNIT-II**

(ii) **General principles of Biophysical chemistry I:** Hydrodynamic properties: Diffusion and sedimentation, determination of molecular weight from sedimentation and diffusion; Introduction of Ultra Centrifugation, Dynamic Light Scattering and Electrophoresis. Spectroscopic properties of proteins and nucleic acid: UV/Vis, Intrinsic fluorescence, Circular dichroism.

#### **UNIT-III**

(iii) **General principles of Biophysical chemistry II:** The concept and application of Chemical and Physical equilibria in Biological system, The equilibrium constant and Standard Gibbs Free energies of reactants and products, Temperature dependence of the equilibrium constant, Double Strand formation in nucleic acid, Ligand-protein binding, Protein denaturation and stability, Introduction of DSC and ITC.

#### **UNIT-IV**

(iv) **Molecular self-assembly and Molecular medicine:** Protein folding kinetics and Biophysical methods, Misfolding and aggregation; Physical basis of conformation diseases, Therapeutic approaches to protein misfolding diseases.

#### **UNIT-V**

(v) **Introduction to structure biology:** Introduction to basic principles of protein X-ray crystallography, protein NMR, Small Angle X-ray scattering (SAXS), and Electron microscopy (EM).

#### **Suggested texts and References:**

- (1) Tinoco, Sauer, Wang, and Puglisi. (2003) Physical Chemistry: Principles and Applications in the Biological Sciences. Prentice Hall, Inc.
- (2) Physical Chemistry for the Life Sciences: Peter Atkins and Julio de Paula
- (3) General review papers Dobson CM. Principles of protein folding, misfolding and aggregation. Semin Cell Dev Biol. 2004 Feb;15(1):3-16.

#### **C 601: Atomic and molecular Spectroscopy**

**(45 + 15 = 60 hrs.)**

#### **UNIT-I**

(i) Born-Oppenheimer approximation - rotational, vibrational and electronic energy levels of homonuclear and heteronuclear diatomic and polyatomic molecules.

#### **UNIT-II**

(ii) Microwave Spectroscopy: Rotational of molecules and rotational spectroscopy of rigid diatomic molecules, Effect of isotopic substitution, The non-rigid rotator and rotational spectra. Rotational spectra of polyatomic molecules – linear, symmetric top and asymmetric top. Techniques and instrumentation.

### UNIT-III

(iii) Infrared spectroscopy: energy levels of vibrating diatomic molecule, simple harmonic oscillator and anharmonic oscillator, diatomic vibrating rotator, vibration-rotation spectra of CO. Breakdown of B-O approximation – interaction of rotations and vibrations. Vibrations of polyatomic molecules – Fundamental vibrations and their symmetry, overtone and combination frequencies, influence of rotation on the spectra of polyatomic molecules – linear and symmetric top molecules. Influence of nuclear spin. Group frequencies and analysis of spectra, Techniques and instrumentation, FTIR spectroscopy.

### UNIT-IV

(iv) Raman Spectroscopy: Classical and quantum theories of Raman effect and molecular polarizability. Pure rotational Raman spectra, Vibrational Raman spectra, Polarization of light and the Raman effect, Structure determination from Raman and infrared spectroscopy, Techniques and Instrumentation, Near IR FT Raman spectroscopy. Resonance Raman and electronic Raman transition and applications.

### UNIT-V

(v) Electronic spectroscopy – Electronic structure and spectra of diatomic and polyatomic molecules. Techniques and instrumentation. Molecular photoelectron spectroscopy.

(vi) Electron spin resonance spectroscopy - spin and spectra - relaxation processes - origin of g-shifts and hyperfine coupling - Tensor quantities - Experimental determination of g, A and D tensors - their interpretation - several examples.

### Suggested texts and References:

(1) G. M. Barrow, Molecular spectroscopy

(2) C.N. Banwell and E. M. McCash, Fundamentals of Molecular spectroscopy, Tata McGraw HillPub. Co. New delhi

(3) J. D. Graybeal, Molecular Spectroscopy, McGraw Hill International Book Co. N.Y.

### C 602: Inorganic Chemistry III

(45+15 = 60 hrs)

#### UNIT-I

##### Chemistry of d-block elements

(i) **General introduction to transition elements** – Electronic structure, Metallic character, variable oxidation state, complexes, magnetic and catalytic properties.

#### UNIT-II

(ii) **Elements of the first transition series:** Occurance, separation, extraction and chemistry of the scandium group (IIIB), titanium Group (IVB), vanadium group (VB), chromium group (VIB), Manganese group (VIIB).

#### UNIT-III

Iron group (VIII(8)), Nickel group (VIII(9)) and Copper group (VIII(10)).

(iii) **Chemistry of the elements of the second and third transition elements:** Niobium group (Group IVB), Niobium and Tantalum (Group VB), Molybdenum and tungsten (Group VIB); Technetium and Rhenium (Group VIIB),

#### UNIT-IV

The Platinum group Metals, Ruthenium and Osmium (Group VIII(8)); Rhodium and Iridium (Group VIII(9)), Palladium and Platinum (Group VIII(10), Silver and gold Group (1B(11)).

#### UNIT-V

(iv) **Chemistry of f-block elements-The lanthanide and actinide elements.**

#### Suggested texts and References:

(1) Advanced Inorganic Chemistry, F. Albert Cotton and G. Wilkinson@1988, John Wiley & Sons.

#### C 603: Organic chemistry III

(45 + 15 = 60 Hrs.)

#### UNIT-I

Chemistry of Natural Products:

(i) **Terpenoids:** Classification, structure, chemistry and biogenesis of some important mono; sesqui, di, and triterpenes.

#### UNIT-II

(ii) **Steroids:** Sterols and bile acids, estrogens, androgens, gestagens and adrenocortical hormones. Hormone production. Cardiac glycosides. Steroidal triterpenes; biogenesis of steroids and correlation with terpenoids.

#### UNIT-III

(iii) **Alkaloids:** Characteristic reactions, general methods of degradation, structure and chemistry of some well-known alkaloids.

#### UNIT-IV

(iv) **Natural Pigments:** anthocyanines, Flavones, flavanones, isoflavones, xanthenes, quinones, pterins, chlorophyll and haemin.

#### UNIT-V

(v) **Carbohydrates:** Stereochemistry, reaction and conformation of monosaccharides, deoxy and aminosugars, hexonic acid and vitamin C, disaccharides, polysaccharides, inositol; gangliosides and other glycosides. Chemistry of vitamins A, B, C and E.

#### Suggested texts and References:

(1) I. L. Finar, Organic Chemistry, Vol. 1 & 2, ELBS.

#### C 604: Nuclear Chemistry

(45 + 15 = 60 hrs.)

#### UNIT-I

(i) **Nuclear Stability:** Concept of nucleus and properties, nuclear mass and binding energy, elemental abundance, radioactive decay laws and equilibria. Nuclear Models: Liquid drop model, Shell model, Fermi gas model, collective model, optical model, concept of spin, parity electric and magnetic moments, isomerism.



## UNIT-II

(ii) **Modes of Decay:**  $\alpha$  decay,  $\beta$  decay, electron captures,  $\gamma$  de-excitation, internal conversion, artificial radioactivity.

(iii) **Nuclear reactions:** Energetics, cross-section, centre of mass system, angular momentum, compound nucleus, statistical model, nuclear fission and fusion, nuclear reactors, Heavy ion induced reactions, Accelerators.

## UNIT-III

(iv) **Applications of radioactivity:** Probing by isotopes, preparation of radioisotopes, Szilard-Chamers' reaction, Concept of tracers, chemical yield, radiochemical purity, Application of radiotracers in Chemical Sciences, uses of nuclear radiations, radioisotopes as a source of electricity.

## UNIT-IV

(v) **Elements of Radiation Chemistry:** Interaction of radiation with matter, radiation dosimetry, radiolysis of water and some aqueous solutions, other radiolytic events.

(vi) **Nuclear Methods:** Activation Analysis – Neutron Activation Analysis (NAA),

## UNIT-V

Charged Particle Activation Analysis (CPAA), X-ray fluorescence (XRF) spectrometry, Ion Beam Analysis – Backscattering Spectrometry (BS), Particle Induced  $\alpha$ -ray Emission (PIGE), Nuclear Reaction Analysis (NRA), Elastic Recoil Detection Analysis (ERDA), Particle Induced X-ray Emission (PIXE).

### Suggested texts and References:

- (1) G. Friedlander, J. Kennedy, Nuclear and Radiochemistry (1981) –J. M. Miller and J. W. Macias
- (2) R. D. Evans, Atomic Nucleus (1955)
- (3) S. Glasstone, Source book of Atomic Energy (1969)
- (4) G. T. Seaborg, Man made elements (1963).
- (5) H. J. Arnikar, Essentials of Nuclear Chemistry (1982).
- (6) C. Keller, The Chemistry of Transuranium Elements (1971).
- (7) J.C. Bailar, H.J. Emelius, R. Nyholm and A.F. Trotman-Dickenson; Comprehensive Inorganic Chemistry, Vol. 5, Pergamon Press, Oxford (1973).

## H601: Ethics of Science and IPR

Introduction to a Collective, Participatory Teaching-learning Program: A Science of Our own. Science Stands the Test of Ethics ... Some indicators. Levels of Moral Development - Does it mean anything?

Medical Ethics: Different themes pertaining to medical ethics including ethical issues in public health.

History, Philosophy and Psychology of Ethics: History of Political Economy and Modern Ethics  
Environmental Ethics

Intellectual Property Rights and Associated Issues: History of Patenting. Digitalizing Culture-I: Free Software and Free Culture. Digitalizing Culture-II: Concentration and appropriation of Power by the few as well as Possibility of Distributive Justice

Journals and Publishers: Monopolistic practices by Academic Publishers Quest for Determining what is Virtuous: Ethics in Practice. Collaborative Projects by the Class.  
Teaching the Teachers and other Virtuous Inquiries.

**CL 601: Chemistry laboratory:**

Experiments based on analytical techniques such as cyclic voltammetry, pulse polarography, electrodeposition, gas chromatography, nuclear magnetic resonance, FTIR, thermal gravimetry methods, atomic absorption spectroscopy etc.

**FOURTH YEAR**  
**SEMESTER –VII**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
C701	Photochemistry	[3 + 1]	4
C702	Chemical biology	[3+ 1]	4
C703	Organometallics & Bio-inorganic Chemistry	[3 + 1]	4
C704	Physical Organic Chemistry	[3 + 1]	4
CPr701	Reading project	-	4
		<b>Lab contact hrs</b>	<b>Credits</b>
CL701	Advanced Chemistry Laboratory-I	[8]	4

**24**

(175 of 240 credits)

**C701: Photochemistry**

(45 + 15 = 60 hrs.)

**UNIT-I**

**Basic Principles of photochemistry:**

**(i) Photophysical processes:** Deexcitation processes for the excited molecules (fluorescence, phosphorescence, delayed emission, nonradiative relaxation, excimer and exciplex formation, heavy atom effect, etc.). Kinetics of excited state processes and quantum yields of different processes.

**(ii) Properties of the excited state:** Acid-base properties, redox potential, geometry, dipole moment, dynamic properties of the excited states.

**UNIT-II**

**(iii) Photoinduced processes:** Photo-dissociation, photo-ionization, intramolecular charge and proton transfer processes, intermolecular electron and proton transfer reactions, conformational relaxations, intra and intermolecular energy transfer processes and other important photochemical reactions. Kinetics and mechanism of photochemical reactions.

(iv) **Applications of photochemistry:** Photosynthesis, vision, solar energy conversion, atmospheric photochemistry, etc.

### UNIT-III

(v) **Studies on ultrafast processes:** Nanosecond, picoseconds and femtosecond laser flash photolysis, fluorescence time domain spectroscopy with special emphasis on energy transfer and electron transfer reactions and studies on excited state properties.

### UNIT-IV

(vi) **Organic Photochemistry** Distinctive features of photochemical reactions, methods of preparative photochemistry, Photochemistry of alkenes, alkynes and related compounds – geometrical isomerism, electrocyclic processes, sigmatropic shifts, di- $\pi$  methane reactions, addition, cycloaddition and oxidative reactions. Photochemistry of aromatic compounds – bond cleavage and hydrogen abstraction reactions, cycloaddition reactions, rearrangements of cyclohexenones and cyclo-hexadienones, thiocarbonyl compounds. Photochemistry of other organic compounds – imines, imminium salts, nitriles and nitro compounds, azo and diazo compounds, diazonium salts, sulphur and halogenated compounds, photohalogenation and photonitrosation reactions. Photooxidation of alkanes.

### UNIT-V

(vii) **Inorganic Photochemistry** Introduction to inorganic photochemistry. Photophysical processes. The electronic absorption spectra of inorganic compounds. Characteristics of the electronically excited states of inorganic compounds. Photoelectrochemistry of excited state redox reactions. Photosensitization. Photochemical reactions; substitution, decomposition and fragmentation, rearrangement, and redox reactions. Selective inorganic photochemistry using laser beams. Inorganic photochemistry in biological processes and their model studies. Ligand field photochemistry of  $d_n$  complexes, photochemistry of carbonyl compounds, energy conversion (solar) and photodecomposition of water.

### Suggested texts and References:

- (1) K.K.Rohatagi-Mukherjee, Fundamentals of Photochemistry, Wiley Eastern, 1978.
- (2) M.S.Wrighton, Inorganic and Organometallic photochemistry, ACS Pub., 1978.
- (3) V. Balzani and V. Carasiti, Photochemistry of Co-ordination compounds, Academic Press, 1970.
- (4) J. D. Coyle, Introduction to Organic Photochemistry, ISBN

### C 702: Chemical Biology

(45 + 15 = 60 Hrs.)

#### UNIT-I

(i) **Structure and the Synthesis of Life:** Central Dogma, Introduction to Biological Chemistry, Artificial gene synthesis: solid-phase DNA synthesis Versus molecular cloning and polymerase chain reaction (PCR). Synthia and *Mycoplasma laboratorium*,

#### UNIT-II

DNA digital data storage, Peptide and protein synthesis. Lipid synthesis, Carbohydrate and membrane synthesis.



**What Chemists Can Do for Biology:** Natural Versus non Natural amino acid, Nonnatural Amino Acids for Site-Specific Protein Conjugation, Bio-orthogonal chemistry, Chemical genetics, reverse chemical genetics.

#### **UNIT-III**

**Biomimetic Chemistry:** Compounds that mimics a biological material in its structure or function, Artificial Enzymes: Chemical transformation, Molecular recognition (Mimic binding), examples of mimics found in research and industry: Cyclodextrins Cryptands,

#### **UNIT-IV**

Catalytic antibodies. Nanozymes- next-generation artificial enzymes, A laboratory procedure designed to imitate a natural chemical process: Biomimetic synthesis, Natural product synthesis, Asymmetric catalysis, Reaction methodology.

#### **UNIT-V**

(iv) **Metabolomics:** Technologies in metabolomics. Nutrigenomics. Other omics. Nuclear Magnetic Resonance Spectroscopy and Mass Spectrometry in metabolomics. Metabolic pathways resources: KEGG, Biocarta. Nutrigenomics and metabolic health. Solved problems and future challenges.

### **C703: Organometallics and Bioinorganic Chemistry**

**(45 + 15 = 60 hrs.)**

#### **UNIT-I**

**Organometallics:** Overview, 18-electron rule, square planar complex. Carbonyl ligand – bonding, binary carbonyl complexes, oxygen-bonded carbonyls, other ligands similar to CO, IR spectrum, main group parallels with binary carbonyl. Pi-ligands – linear and cyclic pi systems, NMR spectra of organometallic complexes.

#### **UNIT-II**

Comparative survey of structure and bonding of metal alkyls and aryls, complexes with  $\pi$  acids, CO and related ligands, complexes with olefins, acetylenes and related unsaturated molecules, catalytic properties of mononuclear compounds, stereochemical non-rigidity in organometallic compounds, boranes, carboranes and metallocarboranes, bimetallic and cluster complexes, structure and applications in catalysis, applications of organometallic compounds in organic synthesis, enantioselective synthesis via organometallic compounds.

#### **UNIT-III**

importance of organometallic compounds in certain biological systems. Other important ligands – complexes containing M – C, M= C, M  $\equiv$  C bonds, hydride and dihydrogen complexes, phosphines and related ligands.

(ii) Organometallic reactions occurring in metal – ligand substitution, oxidative, addition, reductive, elimination. Organometallic reactions involving modification of ligands – insertion and deinsertion, nucleophilic addition to ligands, nucleophilic abstraction, electrophilic reactions.

#### **UNIT-IV**

Homogeneous catalysis and heterogeneous catalysis – use of transition metal complexes, hydroformylation reaction, Walker-Smith synthesis of acetaldehyde, hydrogenation, Monsanto

acetic acid process. Transition metal carbene complexes – structure, preparation and chemistry, metathesis and polymerization reactions. Applications of organometallics to organic synthesis and other applications. Metal cluster compounds - metal-metal bond, carbonyl and non-carbonyl clusters, structure and bonding low dimensional solids, clusters in catalysis.

#### UNIT-V

**(iii) Bio-inorganic chemistry** - biochemistry of iron - its storage, transport and function, copper and zinc proteins, biological activation of oxygen, bioinorganic chemistry of alkali and alkaline earth metal cations, photosynthesis, nitrogen fixation, toxicity of metals. Chemical make up and essential inorganic elements of organisms. Chemistry aspects of metal complexes. Spectral, biochemical and biological methods used in bioinorganic chemistry. Bioinorganic chemistry of Na<sup>+</sup>, K<sup>+</sup>, Mg<sup>2+</sup> and Ca<sup>2+</sup>. Role of metal ions in biology : Proteins and enzymes of V, Mn, Fe, Co, Ni, Cu, Zn and Mo. Structural and functional models. Transport and storage of metal ions. Carcinogenicity of chromium. Selenium in biology.

#### Suggested texts and References:

- (1) G.O.Spessard, G.L.Miessler, Organometallic Chemistry, Prentice Hall, 1997.
- (2) C.Elsehnbroich and A. Salzer, Organometallic Chemistry, 2<sup>nd</sup> Ed., Wiley VCH, 1992.
- (3) F.A.Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, 6<sup>th</sup> Edn., Wiley, 1999.
- (4) N.N.Greenwood and A. Earnshaw, Chemistry of the Elements, 1<sup>st</sup> Edn., Pergamon, 1985.
- (5) S.J.Lippard & J.M.Berg, Principles of bioinorganic chemistry, University Science Books, Mill Valley, 1994.
- (6) I. Bertini, H.B.Gray, S.J.Lippard and J.S.Valentini, Bioinorganic Chemistry, Univ. Sci. Books, Mill Valley, 1994.
- (7) James A.Cowan, Inorganic Biochemistry, VCH Publishers, 1993.

#### C 704: Physical organic chemistry

(45 + 15 = 60 hrs)

#### UNIT-I

**Structure and Models of Bonding:** Basic Bonding Concepts, Bonding and Structure of Reactive Intermediates, Molecular Orbital Theory, electron in a box problem, energies and coefficients of linear pi-systems, Secular Determinant, Huckel MOT, HMOT in cyclic and acyclic pi-systems, Aromatic and antiaromatic systems.

#### UNIT-II

**(ii) Strain and Stability:** Thermochemistry of Stable Molecules, Thermochemistry of Reactive Intermediates, Relation Between Structure and Energetics-Basic Conformational Analysis, Conformations of Acyclic and Cyclic Systems, Electronic Effects.

**Acid-Base Chemistry:** Bronsted Acid-Base Chemistry, Aqueous and Non-Aqueous Systems, Predicting Acid Strength in Solution, Lewis Acids/Bases and Electrophiles/Nucleophiles.

#### UNIT-III

**(iv) Thermal Pericyclic Reactions:** Cycloadditions, Orbital correlation diagram, Frontier Molecular Orbital, Comments on forbidden and allowed reactions, Photochemical pericyclic reactions, D-A cycloadditions, regio- and stereoselectivity, endo-effect, [2+2] cycloaddition, ketene cycloaddition, 1,3-dipolar cycloaddition, ene-reaction, retrocycloaddition, electrocyclic

reactions, torquoselectivity, sigmatropic rearrangements, Claisen and Cope rearrangements, Cheletropic reactions.

#### UNIT-IV

(v) **Reactivity, Kinetics and Mechanisms:** Energy Surfaces and Related Concepts, Postulates and Principles Related to Kinetic Analysis, Kinetic Experiments and Deciphering Mechanisms.  
 (iv) **Experiments Related to Thermodynamics and Kinetics:** Isotope Effects, Substituent Effects, Hammett Plots and Linear Free Energy Relationships, Other Linear Free Energy Relationship, Acid-Base Related Effects, Experiments for Studying Mechanism.

#### UNIT-V

(vii) **Application of physical methods:** Deciphering mechanisms of electrophilic and nucleophilic substitution/additions, eliminations, cyclizations, radical reactions and reactions involving reactive intermediates.

#### Suggested texts and References:

- (1) E. V. Anslyn and D. A. Dougherty, Modern Organic Chemistry, University Science, 2005.
- (2) I. Fleming, Molecular Orbitals and Organic Chemical Reactions, John Wiley, 2009.
- (3) J. Clayden, S. Warren, N. Greeves, P. Wothers, Organic Chemistry, 1st Edition, Oxford University Press, 2000
- (4) F. J. Carey and R. J. Sundburg, Advanced Organic Chemistry, Part A and Part B, 5th Ed., Springer, 2007
- (5) J. March, Advanced Organic Chemistry, 3rd edition, McGraw Hill, 1991.
- (6) S. H. Pine, Organic Chemistry, 5th edition, McGraw Hill, 1987.

### SEMESTER –VIII

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
C801	Chemistry of Materials	[3 + 1]	4
C802	Macro and Supra-molecular chemistry	[3+ 1]	4
C803	Reaction Dynamics	[3 + 1]	4
C804	Computational Chemistry	[3 + 1]	4
		<b>Lab contact hrs</b>	<b>Credits</b>
CL801	Advanced Chemistry Laboratory-II	[10]	5
CPr801	Project	-	4

**25**

(200 of 240 credits)



**UNIT-I****Basic Aspects of the Solid State**

(i) Solid State Structure: Primitive lattice vectors - reciprocal lattice - crystal systems and desymmetrization schemes. Bravais lattices; closed packed structures, octahedral and tetrahedral holes, crystallographic point groups and space groups - organic and inorganic crystal structure motifs - polytypes and polymorphs. perovskites and related structures, normal and inverse spinels.

(ii) Defects and Non-stoichiometry: Intrinsic and extrinsic defects - point, line and plane defects; vacancies, Schottky defects, Frenkel defects - Charge compensation in defective solids - non-stoichiometry, thermodynamic aspects and structural aspects.

**UNIT-II**

(iii) Thermal Properties: Free electron theory, electrical conductivity, Hall effect - band theory, band gap, metals and semiconductors - intrinsic and extrinsic semiconductors, hopping semiconductors - semi-conductor/metal transition - p-n junctions - superconduction, Meissner effects, type I and II superconductors, isotope effect, basic concepts of BCS theory, manifestations of the energy gap, Josephson devices.

(iv) Ionic Conductors: Types of ionic conductors - Mechanism of ionic conduction; interstitial jumps (Frenkel), vacancy mechanism, diffusion - superionic conductors, phase transitions and mechanism of conduction in superionic conductors - examples and applications of ionic conductors.

**UNIT-III**

(v) High T<sub>c</sub> Materials: Defect perovskites - high T<sub>c</sub> superconductivity in cuprates – preparation and characterization of 1-2-3 and 2-1-4 materials - normal state properties, anisotropy, temperature dependence of electrical resistance, optical phonon modes – superconducting state, heat capacity, coherence length, elastic constants, positron lifetimes, microwave absorption - pairing and multigap structure in high T<sub>c</sub> materials - applications of high T<sub>c</sub> materials.

(vi) Magnetic Properties: Classification of magnetic materials - Langevin diamagnetism - Quantum theory of paramagnetism - cooperative phenomena - magnetic domains and hysteresis - magnetism and dimensionality.

(vii) Optical Properties: Optical reflectance - excitons - Raman scattering in crystals - photoconduction - color centers - lasers - photovoltaic effect.

**UNIT-IV**

(viii) Synthesis of Materials: Phase diagrams - preparation of pure materials, mass transport, nucleation and crystal growth - preparative techniques, zone refining, chemical transport, etc.

(ix) Multiphase materials: Ferrous alloys, Fe-C phase transformations in ferrous alloys, stainless steels - non-ferrous alloys - properties of ferrous and non-ferrous alloys and their applications.

(x) Nanocrystalline phase - preparation procedures – special properties - applications

(xi) Thin Films, Langmuir-Blodgett Films: Preparation techniques, evaporation/sputtering, chemical processes, MOCVD, sol-gel etc. - LB film growth techniques - photolithography - properties and applications of thin films, LB films.

**UNIT-V**

(xii) Liquids Crystals: Mesomorphic behavior - thermotropic and lyotropic phases – description of ordering in liquid crystals, the director field and order parameters - nematic and smectic

mesophases, smectic -nematic transition and clearing temperature - homeotropic, planar and twisted nematics - chiral nematics - smectic A and smectic C phases - cholesteric-nematic transition - optical properties of liquid crystals - effect of external field.

(xiii) Materials for Solid State Devices: Rectifiers, transistors, capacitors - IV-V compounds - low-dimensional quantum structures, optical properties.

(xiv) Organic Solids, Fullerenes, Molecular Devices: Conducting organics – organic superconductors - magnetism in organic materials.

(xv) Fullerenes - doped fullerenes as superconductors

(xvi) Nonlinear Optical Materials: Nonlinear optical effects, second and third order – molecular hyperpolarisability and second order electric susceptibility - materials for second and third harmonic generation.

### **Suggested texts and References:**

(1) H.V. Keer, Principles of the Solid State, Wiley Eastern (1993).

(2) N.W. Ashcroft, N.W. Mermin, Solid State Physics, Saunders College, Philadelphia (1976).

(3) W.D. Callister, Material Science and Engineering. An Introduction, Wiley, New York (1985).

(4) Charles Kittel, Introduction to solid state physics, John Wiley & Sons, New York (1968).  
Anthony R. West, Solid State Chemistry and its Applications, John Wiley & Sons, New York (2005).

(5) Lesley E. Smart, Elaine A. Moore, Solid State Chemistry (3<sup>rd</sup> Ed), Taylor & Francis (2005).

(6) N.N. Greenwood, Ionic crystals, lattice defects and non-stoichiometry,

## **C 802: Macro and Supramolecular Chemistry**

**(45 + 15 = 60 hrs.)**

### **UNIT-I**

#### **A. Polymer Chemistry**

(i) Polymerization reactions, mechanism and kinetics – cationic, anionic and radical polymerization. Template, emulsion and electrochemical polymerization, Condensation, ring opening, step growth and radiation polymerization reactions. Coordination complex polymerization, Naturally occurring polymers, Biological polymers, inorganic polymers. Polymerization of cyclic organic compounds. Copolymerization and multicomponent polymerization,

(ii) Thermodynamics and kinetics. Polymerization and depolymerization equilibria - Kinetics of condensation (Step-Growth), Free radical and ionic polymerizations.

### **UNIT-II**

(iii) Physical Characterization: Fabrication and Testing, Relationship between structure and properties - Thermal, flame and chemical resistance - Additives - Electroactive polymers - Biomedical applications. Molecular weight ( $M_n$ ,  $M_w$ ) determination - Morphology -Glass transitions and crystallinity - Conformational analysis. Dynamics of dilute polymer solutions and effect of increasing concentration, NMR and neutron scattering studies.

(iv) Reactions and degradation of polymers, biodegradable polymers. Thermal and oxidative degradation, catalysis by macromolecules, computer applications.

### UNIT-III

#### Supramolecular Chemistry

(i) Introduction to Supramolecular Chemistry.

(ii) Molecular and Chiral Recognition - Self-Organization, Self-Assembly and Preorganization, molecular and chiral recognition, self-Assembly and self-organization, role of preorganization in the synthesis of topological molecules, template reactions, one-pot' reactions.

(iii) Covalent self-assembly based on preorganization - inclusion complexes, host-guest chemistry, early development of host-guest chemistry. pedersen's works on crown ethers, nomenclature, the structure of inclusion complexes, dynamic character of inclusion complexes, the complexes involving induced fit and without it, endo-hedral fullerene, hemicarcerand and soft rebek's tennis ball-like hosts.

(iv) Mesoscopic Structures as an Intermediate Stage Between Molecules (Micro Scale) on the One Hand and Biological Cells (Macro Scale) on the Other – introduction, medium sized molecular aggregates.

### UNIT-IV

(v) Between Classical Organic Chemistry and Biology Understanding and Mimicking Nature-Introduction, the role of self-organization and self-association in the living nature, modeling processes in living organisms.

(vi) On the Border Between Chemistry and Technology - Nanotechnology and Other Industrial Applications of Supramolecular Systems – introduction, between chemistry and solid state physics - crystal engineering, obtaining crystals with desired properties, nanotechnology and other industrial applications of supramolecular systems, supramolecular catalysis.

(vii) The Most Interesting Macrocyclic Ligands which Are Hosts for Inclusion Complexes- . Crown ethers and coronands, cryptates and cryptands, calixarenes, hemispherands, and spherands, carcerands, hemicarcerands and novel 'molecular flasks' enabling preparation and stabilization of short-lived species, cyclodextrins, and their Complexes, endohedral fullerene complexes, nanotubes and other fullerene-based supramolecular systems, dendrimers, cyclophanes and steroids forming inclusion complexes, anion binding receptors and receptors with multiple binding Sites.

### UNIT-V

(viii) Other Exciting Supramolecular Systems- Making Use of the preorganization phenomenon, topological molecules, multiple hydrogen-bonded systems, organic zeolite, metal directed self-assembly of complex, supramolecular architecture, chains, racks, ladders, grids, macrocycles, cages, nanotubes and self-Intertwining strands (helicates).

(ix) The Prospects of Future Development of Supramolecular Chemistry.

#### Suggested texts and References:

1. H.R. Allcock, F.W. Lampe and James Mark, Contemporary Polymer Chemistry, Prentice Hall, Inc. (1990).
2. M.P. Stevens, Polymer Chemistry: An Introduction (2nd Edition) Oxford University Press (1990).
3. F.W. Billmeyer, Jr., Textbook of Polymer Science (3rd Edition) Wiley-Interscience (1984) paperback.
4. A. Ravve, Principles of Polymer Chemistry.
5. Recommended Review Articles in the field of supramolecular chemistry.



6. "Supramolecular Chemistry" by F. Vogtle, John Wiley, 1991.
7. "Crystal Engineering. The Design of Organic Solids" by G.R. Desiraju, Elsevier, 1989.
8. Introduction to Supramolecular Chemistry, Dodzuick Helena.

### **C 803: Reaction dynamics**

**(45 + 15 = 60 hrs.)**

#### **UNIT-I**

**Chain reactions:** general treatment, activation energy, chain length, chain transfer reactions, inhibition, bond dissociation energies, branching chain reactions.

#### **UNIT-II**

**The collision theory:** Dynamics of bimolecular collisions and rate and rate constant of bimolecular reaction, factors determining effectiveness of collisions, Termolecular reactions, unimolecular reactions. Relation between cross section and rate coefficients.

#### **UNIT-III**

**Potential Energy Surfaces::** Long range, empirical intermolecular and molecular binding potentials, Internal coordinates and normal modes of vibration, Potential energy surfaces, ab-initio calculation of potential energy surface, experimental determination of potential energy surfaces.

#### **UNIT-IV**

Details of the reaction path, potential energy surface for electronically excited molecule. Molecular beam scattering, State resolved spectroscopic technique, molecular dynamics of  $H_2 + H$  reaction, state-to-state kinetics of  $F + H_2$  reaction.

#### **UNIT-V**

**(iv) Transition State Theory (TST):** Motion on the potential energy surface, Basic postulates and derivation of TST, dynamical derivation of TST, Quantum mechanical effects on TST, Thermodynamic formulation of TST, Application of TST, Micro-cannonical TST, Variational TST, Experimental observation of TST.

#### **Suggested texts and References:**

- (1) J.I. Steinfeld, J.S. Francisco and W.L. Hase, Chemical Kinetics and Dynamics, Prentice Hall 1989.
- (2) Paul L. Houston, Chemical Kinetics and reaction dynamics.
- (3) R.D.Levine and R.B.Bernstein, Molecular Reaction Dynamics and Chemical Reactivity, Oxford University Press, 1987.
- (4) Sanjay K. Upadhyay, Chemical kinetics and Reaction Dynamics, Springer, 2006

### **C 804 Computational chemistry**

**(45 + 15 = 60 hrs.)**

A brief outline of molecular mechanics, semi-empirical approximations, ab initio methods, basis sets and Z-matrix; Application of these computational methods for prediction of structural and electronic properties of molecules by using standard programs; FMOs in organic chemistry, crystal and ligand field calculations, computation of potential energy surfaces. Conformational

analysis by molecular mechanics; Dynamical and structural studies of molecules using molecular dynamics simulations; Monte Carlo simulations of molecules.

**Suggested texts and References:**

- (1) C. J. Cramer, Essentials of Computational Chemistry: Theories and Models, John Wiley & Sons, 2002.
- (2) David Young, Computational Chemistry: A practical Guide for applying Techniques to Real World Problems, Wiley Interscience, 2001.
- (3) A.R. Leach, Molecular Modelling: Principles and Applications, Pearson Education, 2001.
- (4) J. B. Foresman, A. Frisch, Exploring Chemistry with Electronic Structure Methods. Gaussian Inc., 1996.
- (5) M.P. Allen and D.J. Tildesley, Computer Simulations of Liquids, Oxford, 1987.

**FIFTH YEAR**  
**SEMESTER –IX**

Subject Code	Subject	Contact Hours / Week	Credits
CPr901	Project	-	24

**24**

**(224 of 240 Credits)**

**SEMESTER –X**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
CE1001	Elective I	[3 + 1]	4
CE1002	Elective II	[3+ 1]	4
CE1003	Elective III	[3 + 1]	4
CE1004	Elective IV	[3 + 1]	4

**16**

**(240 of 240 credits)**

(P: Physics, M: Mathematics, C: Chemistry, B: Biology, G: General, E: Elective, Pr: Project)

## **Elective subjects on Physical Chemistry:**

### **Theoretical Organic Chemistry**

Structure and Heats of Formation: Classical mechanical approach - Additivity schemes - Relationship between structure and strain -  $\pi$ -electrons within the classical model - Conformational energies - Introduction of - Inter and intramolecular forces. Quantum mechanical approaches - Applications of semi-empirical and ab initio electronic structure methods - Analysis of computational results - Computer experiments. Reactivity: Substituent effects in reactions - Predictions from theory - Steric and electronic effects - Transition states - A curve crossing model for organic reactions. Structure - Activity correlations. Computer Assisted Organic Synthesis.

### **Suggested Reading:**

1. U. Burkert and N.L. Allinger, Molecular Mechanics, ACS Monograph 177, American Chemical Society, Washington DC, 1982.
2. L. Salem and W.L. Jorgensen, Organic Chemists- Book of Orbitals, Academic Press, 1973.
3. T.H. Lowry and K.C. Richardson, Mechanism and Theory in Organic Chemistry, 3rd Edition, Harper and Row, New York, 1987.

### **Statistical Mechanics**

Ensembles and Averages, equivalence of Ensembles, classical Limit. Monte Carlo and Molecular Dynamics simulations. Distribution functions at equilibrium. Integral equation methods. Perturbation theory. Density functional methods. Molecular fluids. Estimation of thermodynamic functions. Non-equilibrium methods. Linear response theory. Projection operator method. Stochastic processes and Brownian motion. Selected applications to problems in chemical dynamics, relaxation processes and neutron diffraction.

### **Texts/References**

- M.P.Allen and D.J.Tildesley, Computer Simulation in Liquids, Oxford University Press, 1987.  
J.P.Hansen and I.R.McDonald, Second Ed., Theory of Liquids, Academic Press, 1986.  
D.Chandler, Statistical Mechanics, Oxford University Press, 1985.  
H.L.Friedman, A Course in Statistical Mechanics, Prentice Hall, 1983.  
L. D. Landau, E. M. Lifshitz and L.P. Pitaevskii, Statistical Physics Parts I and II, Pergamon Press, 1980

### **Chemical Applications of Group Theory.**

1. The Great Orthogonality Theorem Explained.
2. Projections Operators and SALC's ( Symmetry Adapted Linear Combinations).
3. Symmetry of Metal-Ligand  $\sigma$ -Bonding in simple  $M(X)_n$  ( $n = 1-9$ ) Species. Rarity of the Symmetrical Cube as a Coordination Environment.
4. Infinite Groups -- Their treatment by Expansion of a Finite Group.
5. Molecular Vibrations Revisited. Force Constants and F and G Matrices.
6. Crystallographic Symmetry. Translational symmetry, screw axes, glide planes and the 230 Space Groups.



## **Environmental Chemistry**

Biocycles: C, O<sub>2</sub>, N<sub>2</sub>, P, S, CO<sub>2</sub>, etc. Cycles, biodistribution of the elements, chemical separation. Pollution and its Control a. Atmospheric pollution: gaseous air pollution, greenhouse effect and ozone shield, acid-rain particulate air pollution, radiation hazard. b. Aquatic pollution: agricultural and pesticidal inorganic and organic pollutants, marine pollution, oil spills and oil pollution. c. Industrial pollution: Thermal power, cement, fertilizer, sugar, distillery, drug, paper and pulp and nuclear industry pollution, mining and metallurgy, polymers, etc.

## **Environmental Analytical Chemistry**

Techniques and quantification of pollutants, trace element and radionuclide analysis. Environmental Toxicology and Detoxification Mechanism Chemical solutions to environmental problems, better biodegradability, kinetics of decomposition, clean technology, etc.

## **Suggested Reading**

1. Handbook of Environmental Chemistry (Ed. O. Hutzinger) Springer-Verlag, Vol.1-3.
2. Environmental Inorganic Chemistry (Ed. J. Irgolic and A.E. Martell), VCH Publishers.
3. The importance of Chemical -speciation- in Environmental Processes (Ed. M. Bernhard, F.E. Brinckman and P.J. Sadler) Springer-Verlag.
4. Environmental Chemistry, Vol. 1 and 2, Specialist Periodical Report, The Chemical Society (London).
5. Environmental Instrumentation (L.J. Fristchen and L.W. Gay) Springer-Verlag.
6. Comprehensive Analytical Chemistry (Ed. G. Svehla) Elsevier, Vol. I\_XXVIII

## **Radioisotopes – Production and applications.**

Production of Radioisotope, Basic principles of radioisotope production using nuclear reactors and charged particle accelerators. Szilard-Chalmers effect and its utility in radioisotope production. Concept of radionuclide generators; Growth and decay of activity in a generator; Different types of <sup>99</sup>Mo-<sup>99m</sup>Tc generators; Few other important generator systems such as <sup>90</sup>Sr-<sup>90</sup>Y, <sup>188</sup>W-<sup>188</sup>Re etc. Methods of production of some important radioisotopes (such as <sup>32</sup>/<sub>33</sub>P, <sup>41</sup>Ar, <sup>60</sup>Co, <sup>79</sup>Kr, <sup>82</sup>Br, <sup>90</sup>Sr-<sup>90</sup>Y, <sup>99</sup>Mo-<sup>99m</sup>Tc, <sup>125</sup>I, <sup>131</sup>I, <sup>137</sup>Cs, <sup>153</sup>Sm, <sup>166</sup>Ho, <sup>177</sup>Lu, <sup>186</sup>/<sub>188</sub>Re, <sup>192</sup>Ir, and <sup>11</sup>C, <sup>13</sup>N, <sup>15</sup>O, <sup>18</sup>F, <sup>67</sup>Ga, <sup>123</sup>/<sub>124</sub>I, <sup>201</sup>Tl etc.). Calculations of production yields; Bateman's equation and its utility in production yield calculations. Applications of Radioisotopes in Medicine Concept of nuclear medicine and radiopharmaceuticals, Classification of radiopharmaceuticals, Characteristics of diagnostic (SPECT and PET) and therapeutic radiopharmaceuticals. Basis of designing radiopharmaceuticals, Methods of radiolabeling, New approaches in radiopharmaceuticals chemistry. Some important organ-specific diagnostic radiopharmaceuticals (myocardial imaging, brain imaging, renal imaging, tumor and inflammation imaging, receptor-specific imaging agents etc.). PET radiopharmaceuticals – Principle and applications. Therapeutic radiopharmaceuticals for some specific applications (bone pain palliation, radiation synovectomy, targeted radiotherapy etc.) Concepts of brachytherapy and teletherapy Quality control of radiopharmaceuticals. Basic principles of Radiometric assays for in-vitro estimation of hormones, tumour associated antigens etc. Industrial applications of radiation technology Fundamental aspects of radiation technology, Ionizing radiation: Sources and Effects,

Comparison of different radiation sources for different applications. Radiation dosimetry, Radiation polymerization, Radiation effects on Polymers, Radiation Modification of polymers for industrial applications, Radiation sterilization of Medical products Radiation processing of food, Radiation hygienization of sewage sludge, Radiation processing of flue gases, Application of radioisotopes as tracers in process optimization and trouble shooting in industries.

#### **Isotope tracer applications in hydrology:**

Environmental isotopes and artificial radioisotopes in hydrology. Application of environmental isotopes in studying ground water salinity, pollution, recharge etc.; Artificial radioisotopes in studying dam seepage, effluent dispersion, sediment transport etc.

#### **Reference Books:**

1. Manual for Reactor Produced Isotopes. IAEA-TECDOC-1340, IAEA, 1999.
2. Fundamentals of Radiochemistry. D.D. Sood, A.V.R. Reddy, N.Ramamoorthy. 3rd Edition, Indian Association of Nuclear Chemists and Allied Scientists, 2004.
3. Radiopharmaceuticals : Chemistry and Pharmacology Adrian D. Nunn. Marcel Dekker, 1992.
4. Fundamentals of Nuclear Pharmacy. G.B. Saha. 2nd Edition, Springer-Verlag, 1984.
5. Radionuclides in Therapy. R.P. Spencer, R.H. Sievers, A.M. Friedman. CRC Press, Boca Raton, 1987.
6. PET in Oncology : Basics and Clinical Applications, J. Ruhlmann, P. Oehr, H.J. Biersack. Springer-Verlag, 1998.

#### **Advanced techniques in NMR spectroscopy**

Nuclear magnetic resonance (NMR) phenomenon and the experimental aspects, Chemical shift, indirect spin-spin coupling, direct spin-spin coupling, Relaxation times, nuclear Overhauser effect, polarization transfer, Two-dimensional NMR, correlation spectroscopy (COSY), Nuclear Overhauser effect spectroscopy (NOESY). Hetero-nuclear correlation spectroscopy (HETCOR), Inverse experiments, hetero- nuclear multiple quantum spectroscopy (HMQC), NMR in higher dimensions, NMR of oriented molecules, Structure and dynamics of bio-molecules, NMR in the solid state, Magnetic resonance imaging.

#### **Suggested Reading**

1. Modern NMR Techniques for Chemistry Research, Ed. Andrew E. Derome.
2. Introduction to Mass Spectrometry, Ed. S.K. Aggarwal and H.C. Jain.

#### **Advanced Topics in Inorganic Chemistry**

Electron transfer properties of metal complexes. Molecular recognition. Asymmetric catalysis. Phosphorus compounds as ligands. Cluster chemistry. Bio-inorganic reaction mechanisms. Basic aspects of single crystal diffraction. Molecular metals. Inorganic rings. Transition metal chemistry of macrocycles. Metal ions in medicine. Fluxional molecules.

#### **Text/References**

- 1.W.L.Jolly, Modern Inorganic Chemistry, McGraw, Hill Co., 1984.
- 2.R.W. Hay, Bioinorganic Chemistry, Wiley, 1984.

- 3.M.Day and J.Selbin, Theoretical Inorganic Chemistry, Von. Nostrand, 2nd Ed. 1980.
- 4.H.J.Emeleus and J.J. Anderson, Modern Aspects of Inorganic Chemistry, Von. Nostrand, 1962.
- 5.J.E.Huheey, Inorganic Chemistry, 4th Ed., Harper Collins College Publisher, 1993.
- 6.G.H.Stout and L.H.Jensen, X-ray Structure Determination : A Practical guide, 2nd Ed., John Wiley, 1989.

## **Nano- Materials and Soft Condensed Matters**

### **Nano-materials**

Introduction: Definition of nano-materials, Difference between bulk and Nano-Materials, Quantum size effect, Evolution of electronic Structure from atoms, clusters, nano-materials to bulk solids, Calculation of surface to volume ratio for different structural arrangements, Different Class of Nano-Materials : Metal nano-particles, nano-crystals, Clusters and cluster assembled materials (example of C<sub>60</sub> solid), Semiconductor nanoparticles, Quantum Well/ wire/Dot Core-Shell nanoparticles Polymers, Organic-inorganic nanocomposite, Nano-structured multilayers Self-Assembly, Bio-Materials (poly-peptide), Nanotubes, nanowires, Nano-rods, Synthesis: Chemical precipitation, Sol-Gel method, Ball milling, Physical vapor deposition, Thermal decomposition, Solid state precipitation, Co-sputtering, Silver ion exchange, Ion-implantation, Methods for obtaining monodisperse particles

**Properties:** Electronic Properties : (IP, EA, Reactivity, Electronic Structure, DOS etc. Optical Properties : Electron and hole confinement in Semiconductor quantum dots, Band-gap engineering, Optical absorption and photoluminescence, efficiency of optical process, application of nano-particles in non-linear optical devices, Magnetic Property, High density data storage. Thermo-Mechanical Properties. Applications: Nano-Catalysis : Electro catalysis, Fuel Cell Materials Bio-medical application, Electronic device application, Molecular Electronics, Spintronics, data storage etc. Carbon based Nano-Materials: Carbon Clusters, Fullerece, nano-tubes : Synthesize, Properties and applications.

### **Soft Condensed Matters:**

2.1 Introduction to Soft Matter : Forces, energies, length and time scales in soft matter. Soft matter systems (colloids, surfactants and polymers). Interactions in soft matter (electrostatic, vander Walls, hydrophilic and hydrophobic interactions, depletion interaction). Soft matter in nature (proteins, polysaccharides, membrances).

2.2 Experimental techniques to investigate structure and dynamics in soft matter : Scattering techniques (Small-angle X-ray scattering (SAXS), Ultra-small-angle-X-ray scattering (USAXS), Small-angle (SANS) and inelastic neutron scattering, Static and Dynamic light scattering (SLS & DLS), NMR, Optical microscopy, digital video microscopy, confocal laser scanning microscopy, Atomic Force Microscopy (AFM), Electron microscopy (TEM &SEM). Optical Tweezers [2 lectures].

2.3 Computer simulations : Molecular dynamics (MD), Monte Carlo (MC), Calculation of pair-correlation function, structure factor.

2.4 Colloids : Sterically stabilized and Charge stabilized colloids, Colloidal interactions, Synthesis of monodisperse colloidal particles, characterization, Structural ordering, Dynamics, Phase Transitions and applications of colloids.



2.5 Surfactants: Classification, Micellization and critical micelle concentration. Surface tension. Gibbs adsorption equation and surface excess. Phase behavior of surfactants. Cloud point and Kraft temperature. Liquid crystalline phases in surfactants and block copolymers. Langmuir-Blodgett films, Monolayer, Bilayers and Vesicles.

2.6 Polymer Solutions and Polyelectrolytes : A single ideal chain, mean-squared end to-end distance, radius of gyration. Gaussian chain, Freely jointed chain. Worm-like chain and persistence length. Excluded volume, solvent quality and theta-temperature. Size of a polymer in dilute solutions : osmotic pressure, light scattering and intrinsic viscosity, Polyelectrolytes : Debye-Huckel theory, Donnan equilibrium and manning condensation. Dynamics of polymeric liquids: Maxwell model. Scaling laws based on Rouse theory, Zimm theory and reptation theory. Polymer Gels: Classes of gels and theory of gelation.

### **Reference Books:**

1. Nanoparticles and Nanostructured Films: Preparation, Characterization, and Applications, Ed. J.H. Fendler, (Wiley-VCH, New York, 1998)
2. Fundamental properties of Nanostructured Materials, Eds. D. Fiorani (World Scientific, Singapore, 1994)
3. Advanced Catalysts and Nanostructured Materials: Modern Synthetic Methods, Ed. W.R. Moser (Academic, San Diego, 1996)

## **Advanced Coordination Chemistry**

### **A. Advanced Coordination Chemistry**

**25 hrs.**

Chemistry of Sigma donor and pi-acceptor complexes. Ligand field and molecular orbital theories. Term diagrams in octahedral, tetrahedral and lower symmetries. Electronic dipole selection rules, band intensities, factors influencing band widths. Dichroism studies. Charge transfer spectra. Calculation of ligand field parameters. Magnetic properties of coordination compounds, basic equations of magnetic susceptibility, diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism, temperature independent. paramagnetism and electron delocalisation, effect of zero field splitting. ESR and NMR studies of paramagnetic complexes.

### **Text/References**

1. R.S.Drago, Physical Methods for Chemists, W.B. Saunders Co., 1992.
2. B.N.Figgis, Introduction to Ligand Fields, Wiley Eastern, 1976.
3. A.B.P. Lever, Inorganic Electronic Spectroscopy, Elsevier, 1968.

## **Molecular Bio-Organic Chemistry**

1. New paradigm in synthesis: Rational synthetic design, convergent and divergent strategies, multi-component and Domino reactions, atom economy, high-throughput synthesis, substrate and reagent-controlled asymmetric synthesis.

2. New paradigm in synthetic approaches: Green strategies, biocatalysis and solvent engineering, microwave and microwave-assisted chemistry, non-conventional reaction media (room temperature ionic liquids, super critical fluids, fluorous phase, super-heated steam), template-driven synthesis.

3. New paradigm in functional targets : Design and synthesis of functional molecules/molecular assemblies, non-covalent interactions, electro-magnetic & photoactive organics, organic-inorganic hybrids, organic memory systems for medicinal and separation sciences.

#### **Reference Books**

1. Zhu, J. and Bienayme, H.(Eds.) Multi component Reactions. Wiley-VCH Verlag GmbH & Co. 2005.
2. Jung, G. Combinatorial Chemistry: Synthesis, Analysis, Screening, Wiley, 1999.
3. Bannworth, W. and Felder, E. Combinatorial Chemistry: A Practical Approach. Wiley, 2000.
4. Stephenson, G.R. Advanced Asymmetric Synthesis. Chapman & Hall, 1996.



**Center for Basic Sciences  
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SCHEME OF EXAMINATION  
&  
COURSE STRUCTURE  
Of  
SEMESTER IX and X  
M.Sc. Integrated (Chemistry Stream)  
UNDER  
FACULTY OF SCIENCE  
EFFECTIVE FROM JANUARY 2020**



Center of Basic Science  
Pt. Ravishankar Shukla University  
Raipur (C.G.) 492010  
PH: - 0771-2262864  
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**Approved by Board of Studies in Chemistry**  
Pt. Ravishankar Shukla University, Raipur (C.G.)

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**5-Year Integrated M.Sc. Chemistry**  
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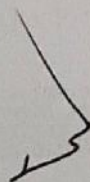
**SEMESTER-X (CHEMISTRY STREAM)**

**SEMESTER -X**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
CE1001	Elective I	[3 + 2]	5
CE1002	Elective II	[3 + 2]	5
CE1003	Elective III	[3 + 2]	5
CE1004	Elective IV	[3 + 2]	5
		Total	20

**Note- Any four papers out of the available seven papers (mentioned in the syllabus) shall be in operation on availability of the instructors with more than 50% of students opting for them.**

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## CEI- Environmental Chemistry

### Unit-I

**Scope:** Environmental pollution, structure of atmosphere, biogeological cycles – oxygen, nitrogen, carbon, phosphorous, sulphur ; biodistribution of elements, air pollutions - reactions in atmosphere, primary pollutants, air quality standards, analysis of CO, nitrogen oxides, sulphur oxides, hydrocarbons and particulate matter, particulate pollution - control methods, vehicular pollution, green house effect and global warming, climatic changes, ozone, photochemical smog, acid rain, sampling, monitoring & control.

### Unit-II

**Hydrosphere:** Water pollution, hydrological cycle, chemical composition, sea water composition, water quality criteria for domestic and industrial uses, BIS and WHO standards, ground water pollution, surface water pollution - lake and river water, eutrophication, marine pollution, water pollutants - biodegradability of detergents – pesticides - endosulfan and related case studies.

### Unit-III

**Classification of industrial waste waters:** Principles of water and waste water treatment - aerobic and anaerobic treatment, industrial waste water treatment, heavy metal pollution, hard water - softening - purification of water for drinking purposes, water treatment for industrial use, electro dialysis, reverse osmosis, other purification methods, chemical speciation of elements.

### Unit-IV

**Water analysis:** Color, odor, conductivity, TDS, pH, acidity, alkalinity, chloride, residual chlorine, hardness, trace metal analysis, elemental analysis, ammonia, nitrite, nitrate, fluoride, sulphide, phosphate, phenols, surfactants, BOD, COD, DO, TOC, nondispersive IR spectroscopy, anode stripping, ICP, AES, Chromatography, ion selective electrodes, neutron activation analysis.

### Unit-V

**Soil pollution:** Soil humus, soil fertility, inorganic and organic components in soil, acid, base and ion exchange reactions in soils, micro and macro nutrients, wastes and pollutants in soil, introduction to geochemistry, solid waste management, treatment and recycling soil analysis, radioactive pollution, disposal of radioactive waste.

### References:

1. H. Kaur, Environmental Chemistry, 6th Edn, Pragathi Prakashan, Meerut, 2011.
2. K.H.Mancy and W.,J.Weber Jr. Wiley, Analysis of Industrial Waste Water, Interscience New York, 1971.
3. L.W. Moore and E. A. Moore, Environmental Chemistry, McGraw Hill Publication, New York, 2002.
4. S. M. Khopkar, Environmental Pollution Analysis, New Age International (P) Ltd, 1993.
5. Colid Baird. Environmental Chemistry, W. H. Freemand and Company, 1995.

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## CE2- Inorganic Rings, Cages and Clusters

### Unit-I

**Main group clusters:** Geometric and electronic structure, three - four and higher connect clusters, the closo-, nido-, arachno- borane structural paradigm, Wade-Mingos and Jemmis electron counting rules, clusters with nuclearity 4-12 and beyond 12. Structure, synthesis and reactivity.

### Unit-II

**Transition metal clusters:** Low nuclearity metal carbonyl clusters and  $14n+2$  rule, high nuclearity metal carbonyl clusters with internal atoms, structure, synthesis and reactivity - capping rules.

### Unit-III

**Isobal analogy:** Heteronuclear clusters - carboranes and heteroboranes, metal clusters - structural prediction of organometallic clusters, main group transition metal clusters: Isobal analogs of p-block and d-block clusters - interstitial systems - cubanes and zintl clusters.

### Unit-IV

**Inorganic homo- & heterocycles:** Synthesis, structure and reactivity - structural variety & properties of borazins and phosphazenes, borides, carbides, silicides, nitrides, phosphides, oxides and sulphides of transition elements, multiple bonds and cluster variety of transition metals.

### Unit-V

**Inorganic rings and polymers:** Definition, variety and merits, P, Si, S, N, & O based polymers, poly-phosphazenes, poly-thiazenes, poly-siloxanes and poly-silanes.

### References:

1. D. M. P. Mingos and D. J. Wales, Introduction to Cluster Chemistry, Prentice Hall, 1990.
2. N. N. Greenwood and E. A. Earnshaw, Chemistry of Elements, Pergamon Press, 1984.
3. I. Haiduc & D. B. Sowerby (Eds.), Inorganic Homo-and Heterocycles Vols. 1 & 2, Academic Press, 1987.
4. J. E. Mark, R. West & H. R. Allcock, Inorganic Polymers, Academic Press, 1992.
5. T. P. Fehlner, J. F. Halet and J-Y. Saillard, Molecular Clusters: A Bridge to Solid-State Chemistry, Cambridge University Press, 2007.
6. P. Braunstein, L. A. Oro, P. R. Raithby, Ed. Metal Clusters in Chemistry, John Wiley and sons, 1999.
7. T. Chivers, I. Manners, Inorganic Rings and Polymers of the p-Block Elements, from Fundamentals to Applications, RSC Publishing, 2009.

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## CE3- Medicinal Chemistry

### Unit-I

**Introduction:** History of medicinal chemistry, general mechanism of drug action on lipids, carbohydrates, proteins and nucleic acids, drug metabolism and inactivation, receptor structure and sites, drug discovery development, design and delivery systems, gene therapy and drug resistance.

### Unit-II

**Classification:** Drugs based on structure or pharmacological basis with examples, synthesis of important drugs such as  $\alpha$  - methyl dopa, chloramphenicol, griseofulvin, cephalosporins and nystatin. Molecular modeling, conformational analysis, qualitative and quantitative structure activity relationships.

### Unit-III

**General introduction to antibiotics:** Mechanism of action of lactam antibiotics and non lactam anti biotics, antiviral agents, chemistry, stereochemistry, biosynthesis and degradation of penicillins - An account of semisynthetic penicillins, acid resistant, penicillinase resistant and broad spectrum semisynthetic penicillins.

### Unit-IV

**Elucidation of enzyme structure:** Mechanism, kinetic, spectroscopic, isotopic and stereochemical studies. Chemical models and mimics for enzymes, design, synthesis and evaluation of enzyme inhibitors.

### Unit-V

**Interactions:** DNA-protein interaction and DNA-drug interaction. Introduction to rational approach to drug design, physical and chemical factors associated with biological activities, mechanism of drug action.

### Recommended books:

1. I. Wilson, Giswald and F. Doerge, Text Book of Organic Medicinal and Pharmaceutical Chemistry, J.B. Lippincott Company, Philadelphia, 1971.
2. A. Burger, Medicinal Chemistry, Wiley Interscience, New York, Vol. I and II, 1970.
3. Bentley and Driver's Text Book of Pharmaceutical Chemistry revised by L.M. Artherden, Oxford University Press, London, 1977.
4. A. Gringauz, Introduction to Medicinal Chemistry, How Drugs Act and Why?, John Wiley and Sons, 1997.
5. G. L. Patrick, Introduction to Medicinal Chemistry, Oxford Univeristy Press, 2001.

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## CE4- Nanochemistry and Nanoscience

### Unit-I

**Introduction to nanoscience and nanotechnology:** Underlying physical principles of nanotechnology, Nanostructured Materials, Size is Everything: Fundamental physicochemical principles, size dependence of the properties of nanostructured matter, quantum confinement, single electron charging, the central importance of nanoscale morphology, Societal aspects of nanotechnology: Health, environment, hype and reality.

### Unit-II

**The advent of the nanomaterial:** Top down and bottom up approaches to building materials, Properties of nanomaterials such as nanoparticles, carbon nanotubes, Overview of selfassembly, Inert gas condensation, arc discharge, RF plasma, plasma arc technique, ion sputtering, laser ablation, laser pyrolysis, ball milling, molecular beam epitaxy, chemical vapour deposition method and electro deposition.

### Unit-III

**The basic tools of nanotechnology:** Scanning electron microscopy (SEM), TEM and EDAX analysis and X-ray diffraction, A brief historical overview of atomic force microscopy (AFM) and an introduction to its basic principles & applications, Optical microscope and their description, operational principle and application for analysis of nanomaterials, UV-VIS-IR spectrophotometers, Principle of operation and application for band gap measurement.

### Unit-IV

**Metal nanoparticles:** Size control of metal nanoparticles and their characterization, study of their properties, optical, electronic, magnetic. Surface plasmon band and its applications, role in catalysis, alloy nanoparticles, stabilization in sol, glass, and other media, change of band gap, blue shift, colour change in sol, glass, and composites, plasmon resonance.

### Unit-V

**Carbon nano structures:** Introduction, Fullerenes, C60, C80 and C240 nanostructures, Properties & applications (mechanical, optical and electrical); Functionalization of carbon nanotubes, reactivity of carbon nanotubes, Nanosensors: Temperature sensors, smoke sensors, sensors for aerospace and defense. Accelerometer, pressure sensor, night vision system, nano tweezers, nano-cutting tools, integration of sensor with actuators and electronic circuitry biosensors.

### Recommended books:

1. T. Pradeep, Nano: The Essentials, Tata McGraw-Hill, New Delhi, 2007.
2. G. Cao, Nanostructures and Nanomaterials – Synthesis, Properties and Applications, Imperial College Press, London, 2004, chapters 3, 4 and 5.

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3. C. N. R. Rao, A. Muller and A. K. Cheetham, *The Chemistry of Nanomaterials*, Volume 1, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004, Chapter 4

### CE5- Surface Chemistry

#### Unit-I

**Surface and Interface Chemistry:** Classifications, micellization, CMC and its determination. Shape and structure of micelles, effect of additives on micellization, thermodynamics of micellization, solubilization and applications, effect of electrolytes on solubilization. Macro and micro emulsions, dispersion and aggregation of solids by surfactants.

#### Unit-II

**Membranes and their applications:** Artificial and natural membranes, Donnan membrane equilibrium, transport of electrolytes, membrane potential and ion selective electrodes.

#### Unit-III

**Adsorption on solids and porous materials:** Model for multilayer adsorption, BET isotherm and application to different types of adsorbents, adsorption by porous, non-porous and microporous solids, Estimation of specific surface area and pore size distribution.

#### Unit-IV

**Colloid systems and their properties:** Origin of the charges, electro-kinetic phenomena, electrophoresis, electroosmosis, sedimentation and streaming potential. The concept of electrical double layer and various models to explain its structure and properties, DLVO theory and stability of colloids. Smoluchowski theory of kinetics of coagulation and distribution of colloids aggregates. Organic and inorganic gels and clay colloids.

#### Unit-V

**Methods to detect interfacial phenomena:** Principle and instrumentation of ATR-FTIR spectroscopy, SFG Spectroscopy.

#### Recommended books:

1. Hunter, R.J., *Foundation of colloid Science*, Oxford University Press, 2009
2. Lyklema, J., *Fundamentals of Interface and Colloid Science*, Academic press San Diego, 2000
3. Adamson, A.W., *Physical Chemistry of Surface*, 5<sup>th</sup> Ed., Jhon Wiley and Sons, New York, 1990
3. Kruyt, H.R., *Colloid Chemistry* Vol. □ and □. Elsevier Press, 1991
4. Gerg, S.J. and Singh, K.S.W., *Adsorption, Surface Area and Porosity*, 2<sup>nd</sup> Ed., Academic Press., U.K. 1982.

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## CE6- Heterocyclic Chemistry

### Unit-I

**Introduction to Heterocycles:** Nomenclature (Hantzsch Widman System), spectral characteristics, reactivity and aromaticity of monocyclic, fused and bridged heterocycles.

### Unit-II

**Nonaromatic heterocycles:** Different types of strains, interactions and conformational aspects on nonaromatic heterocycles. Synthesis, reactivity, and importance of the following ring systems. Azirines, Oxaranes, Thiiranes, Diazirenes, Diaziridines, Azetidines.

### Unit-III

**Five and six-membered heterocycles with two hetero atoms:** Synthesis, reactivity, aromatic character and importance of the following heterocycles: Pyrazole, Imidazole, Oxazole, Thiazole, Pyrimidine, Pyrazine, Oxazine, and Thiazine.

**Heterocycles with more than two hetero atoms:** Synthesis, reactivity, aromatic character and importance of the following heterocycles: Triazoles, Oxadiazoles, Thiadiazoles, Triazines.

### Unit-IV

**Larger ring and other heterocycles:** Synthesis and reactivity of Azepines, Oxepines and Thiopines. Synthesis and rearrangement of Diazepines. Synthesis of Benzoazepines, Benzodiazepines, Benzooxepines, Benzothiepine, Azocines, and Azonines.

### Unit-V

**Banzanellated azoles and dipolar structures:** Banzanellated azoles: Synthesis and reactivity of Benzimidazoles, Benzoxazoles and Benzothiazoles. Heterocycles with Ring-Junction nitrogen: Synthesis and reactivity of Quinolizines, Indolizines and Imidazopyridines. Heterocycles with Dipolar structures: Betaines. Formation, aromaticity and reactivity of pyridine-N-oxides and pyridinium imides. Mesoionic heterocycles: Synthesis and aromaticity of sydnones and 1,3-dipolar addition reaction of mesoionic heterocycles.

### Recommended books:

1. Heterocyclic Chemistry, T. L. Gilchrist.
2. An Introduction to the Chemistry of Heterocyclic compounds, R. M. Acheson.
3. Heterocyclic chemistry, J. A. Joule & K. Mills.
4. Principles of Modern Heterocyclic Chemistry, A. Paquette.
5. Heterocyclic Chemistry, J. A. Joule & Smith.
6. Handbook of Heterocyclic Chemistry, A. R. Katritzky

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## CE7- Advanced Polymer Chemistry

### Unit-I

**Properties of commercial polymers** Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Functional polymers – Fire retarding polymers and electrically conducting polymers, Bio-medical polymers – contact lens, dental polymers, artificial heart, kidney, skin and blood cells

### Unit-II

**Polymer Additives:** Role of additives in polymers, Fillers, plasticizers, anti-oxidants and stabilizers, Flame-retardants, colourants.

### Unit-III

**Natural polymers: Cellulose:** Cellulose nitrate, cellulose acetate. viscose rayon, starch, silk, Rubber and modified rubber.

### Unit-IV

**Polymer supported reagents in organic chemistry:** Preparation and application of polymer supported catalysts, acids, bases, phase transfer catalysts, transition metal complexes etc. Polymer supported reagents and polymer supported protecting groups including "Solid Phase" peptide synthesis.

### Unit-V

**Polymer Degradation and Stabilization:** Types of degradation – Physical and chemical degradation.

**Types of Physical degradation:** a) Thermal degradation b) Photodegradation and stabilization c) Mechanical degradation.

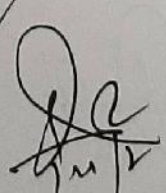
**Types of Chemical degradation:** a) Solvolytic degradation b) hydrolytical degradation c) Oxidative degradation and stabilization d) biodegradation.

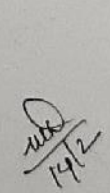
### Recommended books:

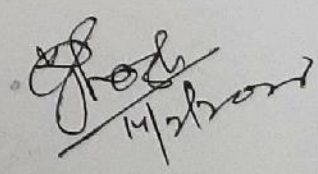
1. Text book of Polymer science ; F.w.Billmeyer J.Willey
2. Polymer science, V.R.Gowarikar, N.V.Vishwanathan and J.Sreedhar, Wiley Eastern
3. Principles of Polymerization, George Odian III.Ed.
4. Organic Polymer Chemistry, K.J.Saunders
5. Polymer Chemistry, Golding
6. Principles of Polymer Chemistry, Flory
7. Physical Chemistry of Macromolecules, D.D.Deshpande, Vishal Publications, 1985
8. Functional monomers and polymers, K.Takemoto, V.Inaki and R.M.Ottanbrite
9. Contemporary polymer chemistry, H.R.alkock and F.W.Lambe, Prentice Hall
10. Physics and Chemistry of polymers, J.M.G.Cowie, Blackie Academic and Professional.

K. Shankar  
14/02/2020

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14.02.2020



  
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(12)

**Center for Basic Sciences  
(CBS)  
SCHEME OF EXAMINATION  
&  
COURSE STRUCTURE  
of  
M.Sc. Integrated (Physics Stream)  
UNDER  
FACULTY OF SCIENCE  
Approved by Board of Studies in Physics  
EFFECTIVE FROM JULY 2015**



Center of Basic Science  
Pt. Ravishankar Shukla University  
Raipur (C.G.) 492010  
PH: - 0771-2262864  
WEBSITE: -[www.prsu.ac.in](http://www.prsu.ac.in)



# Course structure for the M. Sc. (Integrated) Physics Stream July, 2015

(B: Biology, C: Chemistry, M: Mathematics, P: Physics, G: General, H: Humanities,  
BL: Biology Laboratory, CL: Chemistry Laboratory, PL: Physics Laboratory, GL: General  
Laboratory, PE: Physics Elective, PPr: Physics Project)

## FIRST YEAR SEMESTER –I

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
B101	Biology – I	[2 + 1]	3
C101	Chemistry – I	[2 + 1]	3
M100/101	Mathematics – I	[2 + 1]	3
P101	(A) Physics – I (PCM Stream)	[2 + 1]	3
	(B) Physics-I (Biology Stream)		
G101	Computer Basics	[2 + 1]	3
H101	Communication Skills	[2 + 1]	3
		<b>Contact Hours /Week Laboratory</b>	
BL101	Biology Laboratory – I	[4]	1
CL101	Chemistry Laboratory – I	[4]	2
PL101	Physics Laboratory – I	[4]	2
GL101	Computer Laboratory	[4]	2

**25**

**(25 of 240 credits)**

## SEMESTER –II

Subject Code	Subject	Contact Hours /Week Theory+Tutorials	Credits
B201	Biology – II	[2 + 1]	3
C201	Chemistry – II	[2 + 1]	3
M200/201	Mathematics – II	[2 + 1]	3
P201	Physics – II (PCM & Bio Stream)	[2 + 1]	3
G201	Electronics and Instrumentation	[2 + 1]	3
G202	Glimpses of Contemporary Science	[2 + 1]	3
		<b>Contact Hours /Week Laboratory</b>	
BL201	Biology Laboratory – II	[4]	1
CL201	Chemistry Laboratory – II	[4]	2
PL201	Physics Laboratory – II	[4]	2
GL201	Electronics Laboratory	[4]	2

**25**

**(50 of 240 Credits)**

## SECOND YEAR

### SEMESTER –III

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
P301	Mathematical Physics – I	[3 + 1]	4
P302	Classical Mechanics – I	[3+ 1]	4
P303	Electromagnetism	[3 + 1]	4
P304	Waves and Oscillations	[3 + 1]	4
H301	World Literature	[2 + 0]	2
H302	History and Philosophy of Science	[2 + 0]	2
		<b>Contact Hours / Week Laboratory</b>	
PL301	Physics Laboratory – III	[6]	3
GL301	Applied Electronics Laboratory	[4]	2

25

(75 of 240 Credits)

### SEMESTER –IV

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
P401	Mathematical Physics – II	[3 + 1]	4
P402	Quantum Mechanics – I	[3+ 1]	4
P403	Statistical Mechanics – I	[3 + 1]	4
PCB401	Physical and Chemical Kinetics	[3 + 1]	4
G401	Statistical Techniques and Applications	[3+ 1]	4
		<b>Contact Hours / Week Laboratory</b>	
PL401	Physics Laboratory – IV	[6]	3
GL401	Computational Laboratory and Numerical Methods	[4]	2

25

(100 of 240 Credits)

**THIRD YEAR**  
**SEMESTER –V**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
P501	Quantum Mechanics – II	[3 + 1]	4
P502	Classical Mechanics – II	[3+ 1]	4
P503	Atomic and Molecular Physics	[3 + 1]	4
PM501	Numerical Analysis	[3 + 1]	4
G502	Earth Science and Energy & Environmental Sciences	[3+ 1]	4
		<b>Contact Hours / Week Laboratory</b>	
PL501	Physics Laboratory – V	[6]	3
PML501	Numerical Methods Laboratory	[4]	2

**25**  
**(125 of 240 Credits)**

**SEMESTER –VI**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
P601	Electrodynamics	[3 + 1]	4
P602	Nuclear Physics – I	[3+ 1]	4
P603	Condensed Matter Physics – I	[3 + 1]	4
P604	Lasers	[3 + 1]	4
P605	Nonlinear Dynamics and Chaos	[3+ 1]	4
H601	Ethics of Science and IPR	[2+ 0]	2
		<b>Contact Hours / Week Laboratory</b>	
PL601	Physics Laboratory – VI	[6]	3

**25**  
**(150 of 240 Credits)**



**FOURTH YEAR**  
**SEMESTER –VII**

<b>Subject Code</b>	<b>Subject</b>	<b>Contact Hours / Week Theory+Tutorials</b>	<b>Credits</b>
P701	Fluid Mechanics	[3 + 1]	4
P702	Quantum Mechanics – III	[3+ 1]	4
P703	Statistical Mechanics – II	[3 + 1]	4
P704	Reactor Physics and Radiation Science	[3 + 1]	4
		<b>Contact Hours / Week Laboratory</b>	
PL701	Advanced Physics Laboratory – I	[8]	5
PPr701	Reading Project		4

**25**  
**(175 of 240 Credits)**

**SEMESTER –VIII**

<b>Subject Code</b>	<b>Subject</b>	<b>Contact Hours / Week Theory+Tutorials</b>	<b>Credits</b>
P801	Astronomy and Astrophysics	[3 + 1]	4
P802	Accelerator Physics and Applications	[3+ 1]	4
P803	Nuclear and Particle Physics	[3 + 1]	4
P804	Condensed Matter Physics – II	[3 + 1]	4
		<b>Contact Hours / Week Laboratory</b>	
PL801	Advanced Physics Laboratory – II	[8]	5
PPr801	Project		4

**25**  
**(200 of 240 Credits)**

## SEMESTER- IX

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
PPr901	Project		20

**20**  
**(220 of 240 Credits)**

## SEMESTER- X

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
PE1001	Quantum Field Theory	[3 + 1]	4
PE1002	Non-equilibrium Statistical Mechanics	[3+ 1]	4
PE1003	Advanced Mathematical Physics	[3 + 1]	4
PE1004	General Relativity and Cosmology	[3 + 1]	4
PE1005	Experimental Techniques	[3+1]	4
PE1006	Biophysics	[3+1]]	4
PE1007	Quantum Computing and Information	[3+1]	4
PE1008	Disordered Systems	[3+1]	4
PE1009	Particle Physics	[3+1]	4
PE1010	Computational Electrodynamics	[3+1]	4

**Min. 16**  
**(240 of 240 Credits)**

**\*Subject to availability of instructors and minimum number of interested students offering a course. The course structure for the above mentioned elective papers will be provided by the respective instructor.**

## SEMESTER- I

### **P101: (B) Physics-I (Classical Physics): (For Biology Stream)**

#### **UNIT- I**

Concepts of energy and mass, Linear kinematics and dynamics. Concept of force: Conservative and non-conservative forces, Friction. Conservation of momentum, energy, and angular momentum. Work-energy theorem, Centre of mass.

#### **UNIT- II**

Moment of inertia. Rotational kinematics and dynamics, Rigid body motion. Impulse and collisions, Central forces, Kinetic theory of gases, Equipartition of energy.

#### **UNIT- III**

Free oscillations in one, two, and many degrees of freedom. Linearity and superposition principle. Normal modes; Transverse and longitudinal modes. General notion of a continuous string; Resonance; Coupled pendula and oscillators, Normal coordinates.

#### **UNIT- IV**

Probability (chance, fluctuations, random walk, probability distribution, Matter wave, Wave Packet, De-Broglie's theory, uncertainty principle); Curvilinear Coordinates.

#### **UNIT- V**

Vector calculus (differentiation and integration, gradient, divergence, curl, Green's theorem, Gauss' theorem, Stokes' theorem); Fourier series (an introduction).

#### **Suggested texts and References:**

1. "The Feynman lectures in Physics" volume 1, by R. P. Feynman, R. B. Leighton, M. Sands.
2. "An introduction to mechanics", by D. Kleppner and R. Kolenkow.
3. "Mechanics", by Charles Kittel, Walter D. Knight and Malvin A. Ruderman, Berkeley Physics Course Volume 1.
4. "Waves", by F. S. Crawford, Berkeley Physics Course Volume 3.

### **P101: (A) Physics – I (For Physics, Chemistry and Mathematics Stream)**

#### **UNIT- I**

**Mechanics:** Energy, mass and momentum – evolution of the concepts and definitions. Newton's three laws of mechanics; conservative forces, potential energy functions; Conservation of mechanical energy, linear momentum and angular momentum; Applications to athletics; harmonic oscillator, inverse square law force; Kepler's laws.

#### **UNIT- II**

Elementary dynamics of rigid bodies: moment of inertia, angular momentum, rotational kinetic energy, displacement and rotation of rigid bodies. Friction, illustrations of non conservative forces. Impulse, elastic and inelastic collisions, Poisson's hypothesis, deformation energy, Karate punch. Dimensional analysis via examples illustrating Buckingham Pi theorem.



### **UNIT- III**

**Thermodynamics and kinetic theory:** Thermodynamics: Basic notions of thermodynamics; Macroscopic equilibrium, quasistatic processes, reversible processes; Equation of state; Zeroth law; First law for closed systems; Notion of heat, work and internal energy; Notion of state variable and path.

### **UNIT- IV**

Exact and inexact differentials; Ideal gas and Van der Waal's gas equation, some examples of non – pV systems (qualitative); Second law (Kelvin – Planck and Clausius statements); Carnot cycle; Entropy formulation of Second law; Third law (statement); Thermodynamic potentials.

### **UNIT- V**

Kinetic theory: Kinetic theory of ideal gas; Kinetic interpretation of temperature; Adiabatic reversible compression; Boltzmann factor; Derivation of Maxwell's velocity distribution; Average, *rms* and most probable speed; Elementary theory of transport processes (viscosity, thermal conducting and diffusion coefficient); Failure of classical physics.

#### **Suggested texts and References:**

1. Mechanics, Berkeley Physics Course Vol. 1, 2nd Edition, C. Kittel *et al.*, Tata McGraw – Hill Education, 2011.
2. An Introduction to Mechanics, 1st Edition, D. Kleppner and R. J. Kolenkow, Tata McGraw – Hill Education, 2007
3. Thermodynamics, Kinetic theory and Statistical Thermodynamics, 3rd Edition, F. W. Sears and G. L. Salinger, Narosa Publishing House, 1998.
4. Heat and Thermodynamics, 8th Edition, M. W. Zemansky and R. H. Dittman, Tata McGraw – Hill Education, 2011.
5. University Physics, 7th Edition, Francis W. Sears, Mark Zemansky and Hugh D. Young, Massachusetts: Addison Wesley, 1987.
6. Mechanics, D. S. Mathure
7. Thermal Physics, B. K. Agrawal
8. A Treatise on Heat, M. N. Saha and B. N. Shrivastav.
9. Physics: Structure and Meaning L. N. Cooper University press of New England, 1992
10. Fundamentals of Physics, 8th Edition David Halliday, Robert Resnick & Walker New Jersey: John Wiley, 2 2008
11. Mechanics 3rd Edition Keith R. Simon Massachusetts: Addison Wesley Pub. Co., 1987

#### **PL101: Physics Laboratory – I**

Introduction to experimental physics – conceptual and procedural understanding, planning of experiments; Plots (normal, semi-log, log-log); uncertainty / error in measurements and uncertainty / error analysis. Introduction to measuring instruments – concepts of standards and calibration; determination of time periods in simple pendulum and coupled strip oscillator system with emphasis on uncertainty in the measurements and accuracy requirements; study of projectile motion – understand the timing requirements; determination of surface tension of a liquid from the study of liquid drops formed under the surface of a glass surface; determination of Young's modulus of a strip of metal by double cantilever method (use of travelling microscope); study of combination of lenses and nodal points and correspondence to a thick lens; study of thermal expansion of metal – use of thermistor as a thermometer; measurement of small resistance of a

wire using Carey- Fosterbridge and determine electrical resistivity of the wire; study of time dependence of charging and discharging of capacitor using digital multimeter – use of semi-log plot.

**Suggested Texts and References:**

1. Advanced Practical Physics for Students, B. L. Worsnop and H. T. Flint, Methuen and Co. Ltd., London

**SEMESTER-II**

**P201: Physics – II (For Physics, Chemistry and Mathematics Stream) & (For Biology Stream)**

**UNIT- I**

**Electricity and Magnetism:** Electrostatics: Coulomb's law and Gauss' law; Electrostatic potential, uniqueness theorem, method of images; Electrostatic fields in matter; Conductors and insulators; Capacitors and capacitance; Electric current.

**UNIT- II**

Magnetostatics: Biot – Savart law, Ampere's law; Electromagnetic induction; Mutual inductance and self inductance; Magnetic fields in matter. Displacement current; Maxwell's equations; Alternating current circuits; Electric and magnetic properties of matter.

**UNIT- III**

Plane electromagnetic waves in vacuum; Polarisation; Energy and momentum in electromagnetic waves; electromagnetic radiation (qualitative); Dipole radiation formula; Larmor's formula for radiation due to accelerated charge (without proof); Synchrotron radiation (descriptive).

**UNIT- IV**

**Optics:** Interference of two beams and involving multiple reflections; Young's experiment, Fresnel's biprism, Lloyd's mirror.

**UNIT- V**

Optical instruments; Telescope and microscopes; Magnifying power and resolving power. Sources of light and spectra; Dispersion, polarisation, double refraction; Optical activity.

**Suggested texts and References:**

1. Electricity and Magnetism, Berkeley Physics Course Vol. 2, 2nd Edition, Edward M. Purcell, Tata McGraw Hill, 2011.
2. The Feynman Lectures on Physics Vol. 2, R. P. Feynman, R. B. Leighton and M. Sands, Narosa Publications, 2010.
3. The Feynman Lectures on Physics Vol. 3, R. P. Feynman, R. B. Leighton and M. Sands Narosa 2010.
4. Waves, Berkeley Physics Course Vol. 3, Frank S. Crawford, Tata McGraw – Hill, 2011.
5. Fundamentals of Optics, 4th Edition, F. A. Jenkins and H. E. White, Tata McGraw Hill, 2011.
6. University Physics, 7th Edition, Francis W. Sears, Mark Zemansky and Hugh D. Young, Massachusetts: Addison Wesley, 1987.
7. Optics , 4th Edition Eugene Hecht Massachusetts: Addison Wesley
8. "Foundations of Electromagnetic Theory 4th edition, "John R. Reitz, Fredrick Milford & RobertChrist" Massachusetts: Addison Wesley, 1993

9. Fundamentals of Optics 4th Edition Francis A. Jenkins and Harvey E. White "New York Mc Graw Hill Book Company Inc. 2001"
10. Optical Physics 3rd Edition "Stephen G. Lipson, Henry Lipson & D. S. Tannhauser" New York Cambridge University Press 1995
11. Fundamental of Optics 4th Edition Francis A. Jenkins and Harvey E. White Tata Mc Graw Hill 2011.
12. Introduction to Electrodynamics 3rd Edition David J. Griffiths New Jersey: Prentice hall

### **PL201: Physics Laboratory – II**

Review of uncertainty / error analysis; least squares fit method; introduction to sensors / transducers; determination of 'g' (acceleration due to gravity) by free fall method; study of physical pendulum using a PC interfaced apparatus – study variation of effective 'g' with change of angle of plane of oscillation - investigation of effect of large angle of oscillation on the motion; study of Newton's laws of motion using a PC interfaced apparatus; study of conservation of linear and angular momentum using 'Maxwell's Wheel' apparatus; study of vibrations of soft massive spring; study of torsional oscillatory system; study of refraction in a prism - double refraction in calcite and quartz; study of equipotential surface using different electrode shapes in a minimal conducting liquid medium; determination of electrical inductance by vector method and study effect of ferromagnetic core and study the effect of non-linearity of inductance with current.

### **Suggested Texts and References:**

1. Advanced Practical Physics for Students, B. L. Worsnop and H. T. Flint, Methuen and Co. Ltd., London

## **SEMESTER-III**

### **P301: Mathematical Physics – 1**

#### **UNIT- I**

Review of first order differential equations, the notion of Wronskian and its properties, Series solutions of second order differential equations, Frobenius method. Rodrigues formula and classical orthogonal polynomials, recurrence relations, symmetry properties, special values, orthogonality, normalisation.

#### **UNIT- II**

Generating functions. Legendre, Hermite, Laguerre, Bessel and Hypergeometric differential equations. Integral representations of special functions. Expansion of functions in orthonormal basis.

#### **UNIT- III**

Complex variables: Notion of analyticity, Cauchy – Riemann conditions, Harmonic functions; Contour integrals, Cauchy theorem, simply and multiply connected domains, Cauchy integral formula, derivatives of analytic functions.

#### **UNIT- IV**

Laurent series, uniform convergence; Notion of residues, residue theorem, notion of principal values, applications of residues to evaluation of improper integrals, definite integrals, indentation, branch points and branch cuts.



## **UNIT- V**

Fourier series and simple applications. Fourier transforms, Parseval's theorem, convolution, and their simple applications. Laplace transforms, initial value problems, simple applications, transients in circuits, convolution.

### **Suggested Texts and References:**

1. Complex Variables and Applications, R. V. Churchill and J. W. Brown, McGraw-Hill, 2009
2. Complex Variables: Introduction and Applications, 2nd Edition, M. J. Ablowitz and A. S. Fokas, Cambridge 2003
3. Differential Equations, G. F. Simmons, McGraw-Hill, 2006
4. Ordinary Differential Equations, V. I. Arnold, MIT Press 2009
5. Mathematical Methods for Physicists, 7th Edition, G. Arfken and Hans J. Weber, Elsevier 2012

## **P302: Classical Mechanics – I**

### **UNIT- I**

Recap- Newton's laws, vector algebra, gradient; momentum, energy, constraints, conservative forces, potential energy, angular momentum. Inertial and non – inertial frames, fictitious forces.

### **UNIT- II**

Foucault pendulum, effects of Coriolis force. Central forces, conservation of energy and angular momentum, trajectories, orbits,  $1/r$  potential (quadrature), classical scattering, two body problem, centre of mass and relative motions.

### **UNIT- III**

Rigid body motion, moment of inertia tensor, energy and angular momentum, Euler's theorem, motion of tops, gyroscope, motion of the Earth. Introduction to Lagrangian through variational principle, applications of variational principle.

### **UNIT- IV**

Relativity: Historical background, inconsistency of electrodynamics with Galilean relativity. Einstein's hypothesis and Lorentz transformation formula, length contraction, time dilation.

### **UNIT- V**

Doppler shift. Energy, momentum and mass, mass – energy equivalence. Four vector notation, consistency of electrodynamics with relativity.

### **Suggested texts:**

1. An Introduction to Mechanics, 1st Edition, D. Kleppner and R. J. Kolenkow, Tata McGraw – Hill Education, 2007
2. Classical Mechanics, 5th Edition, T. W. B. Kibble, F. Berkshire, World Scientific 2004.
3. Introduction to Special Relativity, R. Resnik, Wiley (India), 2012
4. Spacetime Physics, 2nd Edition, E. F. Taylor, J. A. Wheeler, W. H. Freeman and Co. 1992.
5. Classical mechanics, N. C. Rana, P. S. Joag, Tata McGraw-Hill Education, 2001.

## **P303: Electromagnetism**

### **UNIT- I**

**Electrostatics:** Coulomb's law, Electric field, Gauss' law in differential and integral forms, Scalar potential, Poisson and Laplace equations, Discontinuities in Electric field and potential: electrostatic boundary conditions, Uniqueness theorem, conductors and second uniqueness theorem, method of images, multipole expansion, work and energy in electrostatics.

## **UNIT- II**

**Electric Fields in matter:** dielectrics, polarisation, bound charges, notion of electric displacement, Gauss' law in presence of dielectrics, boundary conditions, linear dielectrics: susceptibility, permittivity, dielectric constant, boundary value problems, energy in dielectric systems.

## **UNIT- III**

**Magnetostatics:** Lorentz force law, steady currents, Biot – Savart law, Ampere's law, vector potential, magnetostatic boundary conditions, multipole expansion for vector potential, magnetic scalar potential. Diamagnets, paramagnets and ferromagnets, magnetisation, bound currents, the H field, boundary conditions, magnetic susceptibility and permeability.

## **UNIT- IV**

**Electrodynamics:** Electromotive force, electromagnetic induction and Faraday's law, induced electric fields and inductance, energy in magnetic fields. Maxwell's equations: equation of continuity and Modification in Ampere's law, Gauge transformations, Lorentz and Coulomb gauge. Maxwell's equations in matter, integral and differential forms, boundary conditions.

## **UNIT- V**

Poynting's theorem, conservation of momentum, angular momentum. Lossy media, Poynting's theorem for lossy media. Wave equation, electromagnetic waves in vacuum, plane waves, propagation in lossless and lossy linear media, absorption and dispersion, reflection at the interface of two lossy media, guided waves.

### **Suggested Texts and References:**

1. Introduction to Electrodynamics, 4th Edition, D. J. Griffiths, Addison-Wesley 2012
2. Classical Electricity and Magnetism, 2nd Edition, W.K.H. Panofsky and M. Phillips, Dover 2005.
3. Engineering Electromagnetics, 2nd Edition, Nathan Eda, Springer 2007

### **P304: Waves and Oscillations**

#### **UNIT- I**

Free oscillations, Simple harmonic motion, damped and forced oscillations; Coupled oscillators, normal modes, beats, infinite coupled oscillators and dispersion relation of sound; vibrating string; travelling and stationary waves; Amplitude, phase and energy. Derivation of wave equation for a string; Longitudinal and transverse waves.

#### **UNIT- II**

Waves in two and three dimensions, the wave vector, wave equation, linearity, superposition, Fourier decomposition of a wave, notion of wave packets, phase and group velocity. Example of mechanical waves (sound waves), speed of sound in air, effect of bubbles, natural observations and qualitative explanations.

#### **UNIT- III**

String and wind instruments. Chaldni plates. Propagation in changing media, continuity conditions, characteristic impedance. Snell's laws and translation invariant boundary, prism, total internal reflection, evanescent waves. Water waves, ocean waves, Tsunami.

## **UNIT- IV**

Electromagnetic waves, polarisation, interference.

## **UNIT- V**

Fraunhofer diffraction. Shocks waves, boat wakes, linear analysis of the Kelvin wake. Alfvén waves (qualitative).

### **Suggested Texts and References:**

1. Waves, Berkeley Physics Course Vol. 3, Frank S. Crawford, Tata McGraw – Hill Education, 2011
2. Introduction to the Physics of Waves, Tim Freegarde, Cambridge Univ. Press 2012
3. The Physics of Waves, Howard Georgi (<http://www.people.fas.harvard.edu/~hgeorgi/new.htm>)

### **H301: Introduction to World Literature**

What is Literature? - a discussion; Introduction to literary terms, genres, and forms of various periods, countries, languages, etc. The Novel: Class study of 'Brave New World' by Aldous Huxley; Group discussions and student presentations on other genres such as the graphic novel, detective fiction, children's literature, etc. Plays: Introduction to the history of theatre, class study of (mainly) two plays: 'Pygmalion' by G. B. Shaw and 'Fire and Rain' by Girish Karnad, the setting up of play – reading group through which the students can be introduced to several other plays. Poetry: Brief introduction; Study of poetic genres, forms, topics, figures of speech, poetic language etc. by analysing various poems from around the world. Short stories, essays and other types of writing by various authors. Screening of films based on literary works, such as Pygmalion (My Fair Lady), Fire and Rain (Agnivarsha), Persepolis (a graphic novel) and a few others.

### **H302: History and Philosophy of Science**

**History of World Science up to the Scientific Revolution:** Introduction about stone age, beginning of agriculture, urban civilization and science. Science in Sumeria, Babylonia and Egypt. Natural philosophy of pre-Socratic Greece. Natural philosophy in Athens. Greek science in the Alexandrian period. Rome and decline of Ancient European science. Science and technology in China. Science and technology in the Muslim world. Technology and the craft tradition in medieval Europe. The scholarly tradition during the middle ages. Renaissance, the Copernican system of the world. Gilbert, Bacon and the experimental method. Galileo and the science of mechanics. Descartes – the mathematical method and the mechanical philosophy. The Protestant reformation and the scientific revolution. Newton –the theory of universal gravitation and optics. Alchemy and iatrochemistry. Medicine, theory of circulation of blood. Growth and characteristics of the scientific revolution.

**History of Ancient Indian Science:** Indian civilization from pre-historic times to the Indus Valley Civilization. Ancient Indian mathematics and astronomy. Ancient Indian medicine and biology. Chemistry, metallurgy and technology in general in ancient India. Strengths, weaknesses and potentialities of ancient Indian science.

**Introduction to Philosophy of Science:** What is science? Scientific reasoning; Explanation in science; Realism and instrumentalism; Scientific change and scientific revolutions.

**Great Scientific Experiments:** Group wise study and presentations by students of historically significant experiments in science.



### **Suggested Texts and References:**

1. A History of the Sciences, Stephen F. Mason, Collier Books, Macmillan Pub. Co. (1962)
  2. A Concise History of Science in India, D. M. Bose, S. N. Sen, B. V. Subbarayappa, INSA (1971)
  3. Philosophy of Science – A Very Short Introduction, Samir Okasha, Oxford Univ Press (2002)
  4. Great Scientific Experiments – Ron Harre, Oxford University Press (1983)
  5. The Story of Physics, Lloyd Motz and Jefferson Hane Weaver, Avon Books (1992)
  6. The Cambridge Illustrated History of World Science, Colin A. Ronan, Cambridge-Newnes (1982)
  7. Encyclopaedia of Classical Indian Sciences, Ed. Helaine Selin and Roddam Narasimha, University Press (2007)
1. Articles from Wikipedia on History and philosophy of science

### **PL301: Physics Laboratory – III**

Frequency response of R-C circuit (concept of cut-off freq and filter) and frequency response of LC circuit; concepts of phase difference between voltage and current in these circuits, phase factor for appliances using AC mains supply; R-L-C (series / parallel) resonance; transient response in RL- C series circuit; study of Newton's rings and interference in wedge shaped films; study of double refraction in calcite / quartz prisms, polarisation of the refracted light rays, optical activity in dextrose and fructose; soldering experience – make a gated timer with indicator; measurement of heat capacity of air; Use of thermocouple / platinum resistance thermometer, use of instrumentation amplifier in amplifying signal from thermocouple; study of the laws of a gyroscope; determination of the charge of an electron by Millikan's oil drop experiment.

### **Suggested Texts and References:**

1. Advanced Practical Physics for Students, B. L. Worsnop and H. T. Flint, Methuen and Co. Ltd., London

### **GL301: Applied Electronics Laboratory**

The course is based on the micro-controller system expEYES and 'Microhope' based on ATmega32 micro controller, developed at IUAC, under a UGC programme.

Use of expEYES kit for monitoring pendulum motion, charge and discharge of capacitor etc to appreciate the goal of the course; Revision of concepts of binary numbers: 'Bit', 'Byte', 'Word', hexa-decimal numbers; Concepts of microprocessor and microcontrollers - CPU, registers, memory (RAM, ROM, different kinds of ROM), data and address bus, decoder, encoder, instruction set, etc. Review of concepts of Digital to Analogue Conversion (DAC) and Analogue to Digital Conversion (ADC), Introduction to micro-controller ATmega32 (which is used in expEYES). Concepts of programming, flow chart, assembly language, and simulator. Concept of I/O programming for ATmega32 Examples of simple I/O program in assembly language, assemble it in an assembler in a PC and download the hex code into microcontroller kit 'microhope' through USB port and verify the operation. C language for writing larger programmes, such as monitoring temperature, which uses ADC of ATmega32. Concept of interrupt and its use in real time data acquisition. Introduction to elements of PYTHON language. Concepts of how expEYES system program resident in ATmega32 is interfaced to commands from PC in Python language; Automated measurement of simple experiments under expEYES, such as, applications such as temperature monitor, pH meter, colorimeter, protein measurement experiments, etc., will be done. As a part of these applications, introduction will be given to sensors, such as temperature sensors, pressure sensors, humidity, pH sensors, photodetectors etc, The experiments will also include I/O programme for keypad inputs and LCD display.

**Suggested Texts and References:**

1. Phoenix: Computer Interfaced Science Experiments, B.P. Ajith Kumar at <http://www.iuac.res.in/~elab/phoenix/>
2. expEYES micro-controller system B.P. Ajith Kumar at <http://www.iuac.res.in/~elab/phoenix/>
3. The AVR micro-controller and embedded systems using assembly and C, by A.A. Mazidi, S. Naimi and S. Mnaimi, Pearson Publications, Delhi, 2013.

**SEMESTER-IV****P401: Mathematical Physics – II****UNIT-I**

Review of curvilinear coordinates, scale factors, Jacobian. Partial differential equations in curvilinear coordinates, classification. Laplace equation, separation of variables, boundary conditions and initial conditions, examples.

**UNIT-II**

Inhomogeneous equations, Green's functions in 1, 2 and 3 dimensions.

**UNIT-III**

**Tensors calculus:** contravariant and covariant notation, Levi-Civita symbol, pseudotensors, quotient rule, dual tensors.

**UNIT-IV**

**Integral equations:** Fredholm and Volterra equations, separable kernel, applications. Elementary group theory and group representations, cyclic, permutation groups; isomorphism, homomorphism.

**UNIT-V**

subgroups, normal subgroup, classes and cosets; orthogonal, rotation group, Lie group; equivalent, reducible, irreducible; Schur's lemma.

**Suggested Texts and References:**

1. Mathematical Methods for Physicists, 7th Edition, G. Arfken and Hans J. Weber, Elsevier 2012
2. Mathematics for Physicists, P. Dennery and A. Krzywicki, Dover 1996
3. Mathematics for Quantum Mechanics, 4th Edition, J. D. Jackson, Dover 2009.
4. Elements of Group Theory for Physicists, A. W. Joshi
5. Lectures on Groups and Vector Spaces for Physicists, C. J. Isham, World Scientific 1989
6. Group Theory and Its Application to Physical Problems, M. Hemmermesh, Dover 1989
6. Elements of Green's Functions and Propagation, G. Barton, Oxford 1989

**P402: Quantum Mechanics – 1****UNIT-I**

Origins of quantum theory (short version); Wave – particle duality, wave packets, uncertainty relation; Time dependent and time independent Schrödinger equation; Interpretative postulates; Hermitian operators, eigenfunctions and eigenvalues; nodal lines and domains; Orthonormality and completion.

## **UNIT- II**

Energy and momentum eigenfunctions; Illustrative one dimensional phenomena (short revision if done in an earlier semester) rigid box; square well and barrier; Linear harmonic oscillator (detailed treatment).

## **UNIT- III**

Abstract vector space formulation of quantum mechanics; Hilbert space, Dirac notation; Hermitian and unitary operators, momentum space representation; Schrödinger and Heisenberg pictures; Linear Harmonic oscillator (matrix theory).

## **UNIT- IV**

Schrödinger equation for a central potential; Orbital angular momentum eigenfunctions (spherical harmonics) and eigenvalues; Bound state solution of Schrödinger equation for Coulomb potential, Hydrogen atom orbits and energies, degeneracy; Electron spin; Addition of two angular momenta, Clebsch – Gordon coefficients.

## **UNIT- V**

**Approximation methods:** stationary perturbation theory (non – degenerate and degenerate); Stark effect; Zeeman effect; Time dependent perturbation theory; Harmonic perturbations, transition probability (Fermi's golden rule).

### **Suggested Texts and References:**

1. Introduction to Quantum Mechanics, 2nd Edition, D. J. Griffiths, Pearson Education 2008.
2. Quantum Mechanics, 3rd Edition, L. I. Schiff, Tata McGraw-Hill 2010.
3. Quantum Mechanics I and II, Claud Cohen Tannoudji, B. Diu and F. Laloe, Wiley 2006
4. Lectures on Quantum Mechanics, S. Weinberg, Oxford University Press 2012.

## **P403: Statistical Mechanics – I**

### **UNIT- I**

Elementary probability theory; random walk; binomial, Poisson, log normal distributions; the Gaussian. Kinetic theory of gases.

### **UNIT- II**

Ensembles; micro-canonical ensemble; canonical ensemble; grand canonical ensemble. Partition functions and their properties; calculation of thermodynamic quantities; Gibbs paradox; the equipartition theorem.

### **UNIT- III**

Two level system and paramagnetism. Validity of the classical approximation; identical particles and symmetry; quantum distribution functions; Bose-Einstein statistics; Fermi-Dirac statistics;

### **UNIT- IV**

Quantum Statistics in the classical limit; physical implications of the quantum-mechanical enumeration of states; conduction electrons in metals.



## UNIT- V

Special topics: the Chandrasekhar Limit; Saha Ionization formula. Systems of interacting particles; Debye approximation; van der Waals equation; Weiss molecular-field approximation

### **Suggested Texts and References:**

1. Thermodynamics and an Introduction to Thermostatistics, 2nd Edition, H. B. Callen, Wiley 2006
2. Fundamentals of Statistical and Thermal Physics, F. Reif, McGraw-Hill Book Company
3. Statistical Physics part 1, 3rd Edition, L. D. Landau and E. M. Lifshitz, Elsevier 2008
4. Statistical Mechanics: A Set of Lectures, R. P. Feynman, W. A. Benjamin, Inc. 1998
5. A Modern Course in Statistical Physics, L. E. Reichl, Wiley 2009

## **PCB 401: Physical and Chemical Kinetics**

### UNIT- I

**Basic Concepts:** Rate, order and molecularity of a reaction, First, second and third order reactions – effect of concentration on reaction rate, rate expressions and integrated form, pseudo-unimolecular and second order autocatalytic reactions, nth order reaction of a single component, effect of temperature on reaction rate – Arrhenius equation and activation energy.

### UNIT- II

**Complex Reactions:** parallel first order reactions, series first order reactions – determination of rate constants by graphical method and the time ratio method. The stationary state, radioactive decay, general first order series and parallel reactions. Competitive, consecutive second order reactions, reversible reactions, equilibrium from the kinetic view point, complex mechanisms involving equilibria.

### UNIT- III

**Kinetic Measurements:** Experimental determination of reaction rates and order of reactions – correlation of physical properties with concentrations, reactions in the phase, reactions at constant pressure, fractional-life period method, initial rate as a function of initial concentrations.

### UNIT- IV

**Reactions in Solutions:** General Properties, Phenomenological theory of reaction rates, Diffusion limited rate constant, Slow reactions, Effect of ionic strength on reactions between ions, Linear free energy relationships, Relaxation methods for fast reactions.

### UNIT- V

**Catalysis:** Homogeneous catalysis in gas phase, in solution, basis of catalytic action, catalysis and the equilibrium constant, acid base catalysis, The Bronsted catalysis law, linear free energy changes, general and specific catalysis. Heterogeneous catalysis. Negative catalysis and inhibition, Surface reactions – effect of temperature and nature of surface. Industrial catalysis.

### **Suggested Texts and References:**

1. Chemical Kinetics : A Study of Reaction Rates in Solution, K.A. Connors, V.C.H. Publications 1990.
2. Chemical Kinetics and Dynamics, J.I. Steinfeld, J.S. Francisco and W.L. Hase, Prentice Hall 1989.
3. Chemical Kinetics and reaction dynamics, Paul L. Houston.
4. Chemical Kinetics, 3rd ed., K.J.Laidler, Harper and Row, 1987.
5. Kinetics and Mechanisms, J.W. Moore and R.G. Pearson, John Wiley and Sons, 1981.
6. Kinetics and Mechanism, A. A. Forst and R. G. Pearson, Wiley International Edition.

### **G401: Statistical Techniques and Applications**

#### **UNIT-I**

Purpose of Statistics, Events and Probabilities, Assignments of probabilities to events, Random events and variables, Probability Axioms and Theorems. Probability distributions and properties: Discrete, Continuous and Empirical distributions. Expected values: Mean, Variance, Skewness, Kurtosis, Moments and Characteristics Functions.

#### **UNIT-II**

Types of probability distributions: Binomial, Poisson, Normal, Gamma, Exponential, Chi-squared, Log-Normal, Student's t, F distributions, Central Limit Theorem.

#### **UNIT-III**

Monte Carlo techniques: Methods of generating statistical distributions: Pseudorandom numbers from computers and from probability distributions, Applications. Parameter inference: Given prior discrete hypotheses and continuous parameters, Maximum likelihood method for parameter inference. Error Analysis: Statistical and Systematic Errors, Reporting and using uncertainties. Propagation of errors, Statistical analysis of random uncertainties, Averaging Correlated/ Uncorrelated Measurements.

#### **UNIT-IV**

Deconvolution methods, Deconvolution of histograms, binning-free methods. Least-squares fitting: Linear, Polynomial, arbitrary functions: with descriptions of specific methods; Fitting composite curves. Hypothesis tests: Single and composite hypothesis, Goodness of fit tests.

#### **UNIT-V**

P-values, Chi-squared test, Likelihood Ratio, Kolmogorov- Smirnov test, Confidence Interval. Covariance and Correlation, Analysis of Variance and Covariance. Illustration of statistical techniques through hands-on use of computer programs.

#### **Suggested Texts and References:**

1. Statistics: A Guide to the Use of Statistical Methods in the Physical Sciences, R.J. Barlow, John Wiley 1989
2. The Statistical Analysis of Experimental Data, John Mandel, Dover Publications 1984
3. Data Reduction and Error Analysis for the Physical Sciences, 3rd Edition, Philip Bevington and Keith Robinson, McGraw Hill 2003

#### **PL401: Physics Laboratory – IV**

Application of PHOENIX (IUAC, New Delhi) microcontroller system for automation in 20 experiments (six sessions); study of acoustic resonance in Helmholtz resonator using PHOENIX system; Resolving power of optical grating; study of atomic spectra in hydrogen, helium, mercury; Application of gamma counts from detected by G.M. counter for study of Poisson and Gaussian distributions; study of black body radiation by optical and thermal radiations; study of electrically coupled oscillators – normal and transient response. Assembling components for an experiment on thermal and electrical conductivity of metals and making of measurements.

#### **Suggested Texts and References:**

1. Phoenix: Computer Interfaced Science Experiments – <http://www.iuac.res.in/~elab/phoenix/>
2. The Art of Experimental Physics, D. W. Preston and D. R. Dietz, Wiley 1991

3. Manual of Experimental Physics with Indian Academy of Sciences, Bangalore kit, R. Srinivasan and K.R.S. Priolkar

### **GL401: Computational Laboratory and Numerical Methods**

GNU Plot, FORTRAN90, Pointers and Object Oriented Programming

I. The nature of computational physics: Machine representation, precision and errors in computation. Errors and uncertainties. E.g. One should understand how to analyze whether a calculation is limited by the algorithm or round-off error. Single/double precision.

II. Basic tools for numerical analysis in science: Solution of algebraic functions – Fixed point method, Newton-Raphson method, Secant method. Numerical Integration – Rectangular method, trapezoidal method. Lagrange's interpolation.

III. Matrix Algebra: Approximate solution of a set of linear simultaneous equations by Gauss-Sidel iteration method. Exact solution by Gaussian elimination. Inversion of a matrix by Gaussian elimination. Determining all the eigenvalues of a real symmetric matrix by Householder's method of tridiagonalization followed by QR factorization of the tridiagonalized matrix.

IV. Differential Equations (ODE and PDE): Solution of an ODE by Euler's method and Runge-Kutta (4) method – comparison of convergence Solution of partial differential equation (Laplace's equation and Poisson's equation) – Boundary Value Problem – solved using Gauss-Sidel iteration followed by plotting using GNUPlot

V. Nonlinear Systems, dynamics: Fractals – generating the Mandelbrot set and Julia sets. Definition of each. Solution of nonlinear set of ODEs – Lorenz equations – Observation and definition of strange attractor and sensitive dependence upon initial conditions (butterfly effect). Study of the logistic map – non linear dynamical system – obtaining a bifurcation diagram and estimating Feigenbaum's constant.

VI. Fourier analysis of nonlinear systems: Getting used to programming using FFT subroutines. Understanding the relationship between time-domain and frequency domain. Transforming a Gaussian, understanding how temporal FWHM and spectral FWHM are related. Solving a nonlinear PDE which is amenable to solution by multiple steps of FFTs.

## **SEMESTER-V**

### **P501: Quantum Mechanics – II**

#### **UNIT- I**

Collision theory: Scattering cross section; Scattering by spherically symmetric potential; Differential cross section, phase shift; Scattering by rigid sphere; Born approximation.

#### **UNIT- II**

Path integral formulation of quantum mechanics; The WKB approximation, solution near a turning point, the connection formulas; Tunnelling through a barrier; The adiabatic approximation.

#### **UNIT- III**

Variational method, expectation value of energy, application to excited states, ground state of He-atom, Zero point energy of one dimensional harmonic oscillator, Vander-waals interaction.



#### **UNIT- IV**

Foundations (Introductory ideas): The EPR paradox, quantum entanglement; Bell's theorem, the No-clone theorem, Schrodinger's cat; Decoherence, quantum Zeno paradox.

#### **UNIT- V**

Symmetry in quantum mechanics; Translation, rotation and space inversion operators; Identical particles; Symmetrical and anti-symmetrical wave functions; Spin – statistics connection (empirical); Density matrix; Equation of motion of density matrix.

#### **Suggested Texts and References:**

1. Introduction to Quantum Mechanics, 2nd Edition, D. J. Griffiths, Pearson Education 2008.
2. Quantum Mechanics, 3rd Edition, L. I. Schiff, Tata McGraw-Hill 2010.
3. Quantum Mechanics I and II, Claud Cohen Tannoudji, B. Diu and F. Laloe, Wiley 2006
4. Lectures on Quantum Mechanics, S. Weinberg, Oxford University Press 2012.

#### **P502: Classical mechanics – II**

##### **UNIT-I**

Variational principle (revisited), Lagrangian formulation, constraints, generalised coordinates, applications. Hamilton's equations of motion (from Legendre transformation), Hamiltonian and total energy, cyclic coordinates, variational principle.

##### **UNIT-II**

Small oscillations, single oscillator, damped and forced oscillations, coupled oscillators, normal modes.

##### **UNIT-III**

Canonical transformations, Poisson brackets, conservation theorems.

##### **UNIT-IV**

Hamilton – Jacobi theory, action – angle variables. Canonical perturbation theory, time dependent and time independent.

##### **UNIT-V**

Lagrangian formulation of continuous media as a limiting case, extensions.

#### **Suggested Texts and References:**

1. Classical mechanics, N. C. Rana, P. S. Joag, Tata McGraw-Hill Education, 2001.
2. Mechanics, L. D. Landau, E. M. Lifshitz, Elsevier 2005.
3. Regular and Chaotic Dynamics, 2nd Edition, A. J. Lichtenberg, M. A. Leiberman, Springer 1992.
4. Classical mechanics, 3rd Edition, H. Goldstein, C. P. Poole, J. Safko, Pearson Education 2011.

#### **P503: Atomic and Molecular Physics**

##### **UNIT- I**

**Many – electron atoms:** One – electron wavefunctions and energies in Coulomb potential (revision); Atomic orbitals, spin – orbit coupling, Thomas precession, fine structure; Alkali atoms; Helium ground state and excited states, direct and exchange integrals; Many – electron atoms: LS and jj coupling schemes; Hartree – Fock method; Pauli's principle and the Periodic Table; Nuclear spin and hyperfine structure.

## **UNIT- II**

**Atoms in External Fields:** Quantum theory of normal and anomalous Zeeman effect, Linear and quadratic Stark effect; Semi – classical theory of radiation; Absorption and induced emission; Einstein's A and B coefficients, dipole approximation, intensity of radiation, selection rules.

## **UNIT- III**

Two level atom in a coherent radiation field, Rabi frequency, radiative damping, optical Bloch equation, Broadening of spectral lines (Doppler, pressure and power broadening).

## **UNIT- IV**

**Lasers:** Basic concepts, rate equation and lasing conditions, working of some common lasers. Doppler free laser spectroscopy; Crossed – beam method, saturated absorption spectroscopy, two photon spectroscopy; Laser cooling and trapping (descriptive); Atom interferometry (descriptive).

## **UNIT- V**

**Molecules:** Ionic and covalent bonding, Hydrogen molecular ion ( $H_2^+$ ), Born – Oppenheimer approximation; Bonding and anti – bonding orbitals, Hydrogen molecule; Heitler – London method, Molecular orbital method, hybridisation, quantum mechanical treatment of rotational and vibrational spectra (diatomic and polyatomic molecules); Electronic spectra, Raman effect (classical and quantum theory); Vibrational and rotational Raman spectra; Electron spin resonance.

### **Suggested Texts and References:**

1. Atomic Physics, Christopher Foot, Oxford University Press, 2005.
2. Intermediate Quantum Mechanics, 3rd Edition, H. A. Bethe and R. W. Jackiew, Persius 1997
3. The Physics of Atoms and Quanta: Introduction to Experiments and Theory, H. Haken, H. C. Wolf and W. D. Brewer, Springer 2005
4. Molecular Physics and Elements of Quantum Chemistry: Introduction to Experiments and Theory, H. Haken, H. C. Wolf and W. D. Brewer, Springer 2010.

## **PM501: Numerical Analysis**

### **UNIT- I**

Error, its sources, propagation and analysis; Errors in summation, stability in numerical analysis. Linear algebraic equations: Gaussian elimination, direct triangular decomposition, matrix inversion.

### **UNIT- II**

Rootfinding: review of bisection method, Newton's method and secant method; real roots of polynomials, Laguerre's method. Matrix eigenvalue problems: Power method, eigenvalues of real symmetric matrices using Jacobi method, applications.

### **UNIT-III**

Interpolation theory: Polynomial interpolation, Newton's divided differences, forward differences, interpolation errors, cubic splines. Approximation of functions: Taylor's theorem, remainder term; Least squares approximation problem, Orthogonal polynomials.

### **UNIT- IV**

Numerical integration: review of trapezoidal and Simpson's rules, Gaussian quadrature; Error estimation. Numerical differentiation. Monte Carlo methods.

## **UNIT- V**

Least squares problems: Linear least squares, examples; Non – linear least squares. Ordinary differential equations: stability, predictor – corrector method, Runge – Kutta methods, boundary value problems, basis expansion methods, applications. Eigenvalue problems for differential equations, applications. Solutions of PDE's using differential quadrature: elementary treatment. Applications to diffusion equation, wave equation, etc.

### **Suggested Texts and references:**

1. An introduction to Numerical Analysis, 2nd Edition, Kendall Atkinson, Wiley 2012
2. Numerical Methods for Scientists and Engineers, H. M. Antia, Hindustan Book Agency 2012.
3. Numerical Recipes in Fortran, 2nd Edition, W. H. Press *et al.*, Cambridge University Press 2000.

## **G501: Earth Science and Energy & Environmental Sciences**

### **Earth Science**

Origin of the earth, type of rocks in different layers, their physical and chemical properties, mechanism of their formation and destruction. Radioactivity and its role in geochronology, Plate tectonics and geodynamics and the role of mantle plumes in sustaining these processes. Gravity, electrical and magnetic properties of the different layers in the earth. Their variations in different geological terrains. Instrumentation, field procedures used in these studies. Response of the earth to the elastic (Seismic) and electromagnetic waves, use of this phenomena to study the earth's interior. Geodynamo and the internal magnetic field of the earth. Paleomagnetic studies, Polar wandering and reversal, possible theoretical arguments for understanding the phenomena. Seismology and its use in understanding of the different layers in the earth's interior. Utility of the different geophysical techniques (discussed above) in exploration for academic as well as for harnessing resources.

### **Suggested Texts and references:**

1. The magnetic field of the Earth, Merrill, R.T. McElhinny, M.W. and McFadden, P.L. International Geophysical Series.
2. Earth Science by Edward J. Tarbuck, E.J. and Lutgens, F.K.
3. Introduction to Applied Geophysics: Exploring the Shallow Subsurface Burger, H.R., Sheehan, A.F., C.H.
4. Mantle Plumes and Their Record in Earth History, Condie, K.C., 2001, Cambridge University Press, Cambridge, UK
1. Applied Geophysics (Paperback) W M Telford, Robert E Sheriff and L P Geldart.

### **Energy and Environmental Sciences**

Introduction to Environmental Science. Natural Environments: Ecosystems and ecology, biodiversity. Socio-cultural environments: demography, population density, human rganizations. Land use and its planning. Global climate change and effects on environment. Carbon cycle from human activity, calculation of carbon budgets. Water harvesting, storage and treatment. Natural calamities, hazards, and effects of human activity: Chemical and other technological hazards. Various case studies of natural calamities and human-induced disasters. Causes, effects, forecasting, preparedness, planning measures, technological solutions, social interventions. Concept of sustainability, individual and social, and local and global actions for a sustainable future. Introduction to energy Sources - evolution of energy sources with time. Power production, per capita consumption in the world, and relation to development index. Energy scenario in India: Various issues related to consumption and demands -energy crisis issues in India. Renewable and



non-renewable energy sources - technology and commercialization of energy sources, local (decentralized) versus centralized energy production, constraints and opportunities of renewable energy (hydrocarbon and coal based energy sources). Energy conservation – calculation of energy requirements for typical and home and industrial applications. Alternative to fossil fuels - solar, wind, tidal, geothermal. Bio-based fuels. Hydrogen as a fuel. Energy transport and storages, comparison of energy sources - passage from source to delivery (source, production, transport, delivery) - efficiencies, losses and wastes. Nuclear energy: Power production: Components of a reactor and its working, types of reactors and comparison. India's three stage nuclear program. Nuclear fuel cycle. Thorium based reactors. Regulations on nuclear energy.

### **Energy and Environmental Sciences**

1. Energy in Perspective, J. B. Marion, University of Maryland, Academic Press, (1974)
2. Energy and Environment, Robert A. Ristinen and Jack J. Kraushaar, 2nd Edn., John Wiley and Sons, Inc. (2006).
3. Renewable Energy, Boyle Godfrey, Oxford University Press (2004)
4. Environment, Problems and Solutions, D.K. Asthana and Meera Asthana, S.Chand and Co.(2006)
5. Text Book on Environmental Chemistry, Balaram Pani, I.K. International Publishing House(2007).

### **PL501: Physics Laboratory – V**

Study of diffraction by single slit, double slit and multiple slits leading to grating, quantitative determination and compare with simulation; Study of Michelson interferometer and determination of refractive index of air; study of Fabry-Perot interferometer; Study of Zeeman effect using Fabry- Perot Interferometer; study of characteristics of scintillation counter used in nuclear radiation detection; study of Hall effect in semiconductors; Introduction to Labview software for automation and use of NI data acquisition card in PC (six sessions).

### **Suggested Texts and references:**

1. The Art of Experimental Physics, D. W. Preston and D. R. Dietz, Wiley 1991

### **PML501: Numerical Methods Laboratory**

The methods developed in Numerical Analysis (P501) are to be implemented on a computer. Emphasis to be given on applications to physical problems.

### **Suggested Texts and references:**

1. Numerical Recipes in Fortran, 2nd Edition, W. H. Press *et al.*, Cambridge University Press 2000
2. An Introduction to Computational Physics, 2nd Edition, Tao Pang, Cambridge University Press 2010

## **SEMESTER-VI**

### **P601: Electrodynamics**

#### **UNIT- I**

Review of Maxwell's equations, vector and scalar potentials, gauge transformations.

Radiating systems: electric dipole fields and radiation, magnetic dipole and electric quadrupole fields, antenna, spherical wave solutions of the scalar wave equation.

## UNIT- II

Multipole expansion of the electromagnetic fields, energy and angular momenta of multipole radiation, angular distribution of multipole radiation, multipole moments, multipole radiation in atoms and nuclei, multipole radiation from linear centre fed antenna.

## UNIT- III

Scattering and Diffraction problems: scattering at long wavelength, perturbation theory of scattering, explanation of blue sky (due to Rayleigh), scalar diffraction theory.

## UNIT- IV

Covariant formulation of electrodynamics: four vector potential, electromagnetic field tensor, covariant description of sources in material media, field equations in a material medium. Retarded potentials, Jefimenko's generalisations of Coulomb and Biot – Savart laws, Lienard – Wiechert potentials.

## UNIT- V

Fields of a moving charge. Cerenkov radiation. Covariant formulation of the conservation laws of electrodynamics.

### **Suggested Texts and References:**

1. Introduction to Electrodynamics, 4th Edition, D. J. Griffiths, Addison-Wesley 2012
2. Classical Electricity and Magnetism, 2nd Edition, W.K.H. Panofsky and M. Phillips, Dover 2005.
3. Classical Electrodynamics, 3rd Edition, J. D. Jackson, Wiley 2012
4. Lectures on Electromagnetism, 2nd Edition, Ashok Das, Hindustan Book Agency 2013.

## **P602: Nuclear Physics – I**

### UNIT- I

**Nuclear Properties:** Size – nuclear radius, charge distribution, matter distribution. Mass- binding energy, liquid drop model/mass formula. Spin, Parity, isospin. Electromagnetic moments- magnetic dipole and electric quadrupole moments/nuclear shapes.

### UNIT- II

Nuclear stability, alpha, beta, gamma decays, fission. Experimental methods for size, mass, spin, moments to be included.

### UNIT-III

**Nuclear Forces:** Nuclear interaction, saturation of nuclear density, constancy of binding energy per nucleon. Bound two nucleon system, Deuteron problem, absence of bound pp, nn. N-N scattering – as a function of energy, phase shift, cross section. Salient features of nuclear force. Yukawa's theory of nuclear interaction (basics).

### UNIT- IV

**Nuclear Structure:** Magic numbers, shell model, spin orbit interaction, deformed shell model. Nuclear excited states vibration, rotation, Collective model. Electromagnetic interactions in nuclei: multipole transitions, selection rules, life times, electron capture, internal conversion, isomers, Coulomb excitation.

## UNIT- V

**Nuclear Reactions:** Kinematics, Q value, excitation energy, conservation laws, cross section, mean free path. Types of nuclear reactions, experimental observables, excitation function, angular distribution, spectra. Compound nuclear reactions, Resonances, level density, temperature, Bohr model. Direct nuclear reactions, optical model, pick up and stripping reactions, spectroscopic factor Nuclear fission and fusion reactions.

### **Suggested Texts and References:**

1. Introductory Nuclear Physics, K.S. Krane, Wiley 2008
2. Concepts of Nuclear Physics, B. L. Cohen, McGraw Hill 1971
3. Introductory Nuclear Physics, S. S. M. Wong, Prentice – Hall 2010
4. Introduction to Nuclear and Particle Physics, 2nd Edition, A. Das and T. Ferbel, World Scientific 2004

## **P603: Condensed Matter Physics – I**

### UNIT- I

**Crystal Structure and x-ray diffraction:** Crystalline and amorphous solids, translational symmetry. Elementary ideas about crystal structure, lattice and bases, unit cell, reciprocal lattice, fundamental types of lattices, Miller indices, lattice planes, simple cubic, f.c.c. and b.c.c. lattices. Simple crystal structures, Closed packed structure, Determination of crystal structure with X-rays, Neutrons and Electron diffraction-Diffraction of waves by crystals, Laue and Bragg equations, Brillouin Zones, Fourier Analysis of the basis. Debye waller factor, X ray broadening -size and temperature effects. X-ray diffraction of liquids and disordered solids- introduction to radial distribution functions.

### UNIT- II

**Lattice Vibrations:** Elastic waves, Thermal properties: Einstein's and Debye's theories of specific heats of solids, Thermal conductivity, Phonons, Lattice waves, Dynamics of a chain of similar atoms and chain of two types of atoms; optical and acoustic modes; Inelastic scattering of x-rays, neutrons and light by phonons, Optical properties of solids: interaction of light with ionic crystals. Raman scattering and Brillouin scattering.

### UNIT- III

**The Free electron model:** Drude Model, Electron conductivity, Heat capacity of conduction electrons, Fermi surface, Sommerfield model, Thermal conductivity of metals, Hall effect, AC conductivity and optical properties, Wiedemann-Franz law, Failure of the Free-electron model, optical properties of metals.

### UNIT- IV

**Basics of Semiconductors and device:** Crystal structure, Band structure, Intrinsic and extrinsic semiconductors, Concept of majority and minority carriers, Energy gap, Mobility, conductivity, Hall effect, Diffusion, Optical properties: Absorption, Luminescence, Photoconductivity, effect of disorder on absorption. Interpretation of energy band diagrams. Devices: p-n diode (derivation of Shockley equation), tunnel diode, photodiode, solar cell, LED, Lasers.

### UNIT- V

**Superconductivity:** Introduction (Kamerlingh Onnes experiment), effect of magnetic field, Type-I and type-II superconductors, Isotope effect. Meissner effect. Heat capacity. Energy gap. Electrodynamics of superconductivity: London's equation, Thermodynamics of the transition, Intermediate state of Type 1, Mixed state of type 2, Flux Quantization, Salient points of BCS theory, Cooper problem, Definition of coherence length, Josephson effect



### **Suggested Texts and References:**

1. Elementary Solid State Physics, M. Ali Omar, Pearson Education 2008.
2. Introduction to Solid State Physics, 8th Edition, C. Kittel, Wiley 2012.
3. Solid State Physics, N. W. Ashcroft and N. D. Mermin, Cengage 2003.
4. Physics of Semiconductor Devices, 3rd Edition, S. M. Sze and K. K. Ng, 2007.
5. Introduction to Superconductivity, A. C. Rose -Innes, E. H. Rhoderik, Pergamon Press
6. Solid State Physics, J. P. McKelvey, Krieger Publishing Co. 1993.
7. Electron theory of solids, J. M. Ziman, Cambridge University Press, 2011.

### **P604: Lasers**

#### **Unit- I**

**Laser Characteristics** –Spontaneous and stimulated emission, Einstein’s quantum theory of radiation, theory of some optical processes, coherence and monochromacity, kinetics of optical absorption, line broadening mechanism, Basic principle of lasers, population inversion, laser pumping, two & three level laser systems, resonator, Q-factor, losses in cavity, threshold condition, quantum yield.

#### **Unit – II**

**Laser Systems-** Solid state lasers- the ruby laser, Nd:YAG laser, ND: Glass laser, semiconductor lasers – features of semiconductor lasers, intrinsic semiconductor lasers, Gas laser -neutral atom gas laser, He-Ne laser, molecular gas lasers, CO<sub>2</sub> laser, Liquid lasers, dye lasers and chemical laser.

#### **Unit-III**

Advances in laser Physics, Production of giant pulse -Q-switching, giant pulse dynamics, laser amplifiers, mode locking and pulling, Non-linear optics, Harmonic generation, second harmonic generation, Phase matching, third harmonic generation, optical mixing, parametric generation and self-focusing of light.

#### **Unit – IV**

Multi-photon processes; multi-quantum photoelectric effect, Theory of two-photon process, three- photon process, second harmonic generation, parametric generation of light, Laser spectroscopy : Rayleigh and Raman scattering, Stimulated Raman effect, Hyper-Raman effect, Coherent anti-stokes Raman Scattering, Photo-acoustic Raman spectroscopy.

#### **Unit – V**

**Laser Applications** – ether drift and absolute rotation of the Earth, isotope separation, plasma, thermonuclear fusion, laser applications in chemistry, biology, astronomy, engineering and medicine.

Communication by lasers: ranging, fiber Optics Communication, Optical fiber, numerical aperture, propagation of light in a medium with variable index, pulse dispersion.

#### **TEXT AND REFERENCE BOOKS:**

1. Laud, B.B.: Lasers and nonlinear optics, (New Age Int.Pub.1996).
2. Thyagarajan, K and Ghatak, A.K.: Lasers theory and applications (Plenum press, 1981).
3. Ghatak, A.K.and Thyagarajan, K : Optical electronics (Cambridge Univ. Press 1999).
4. Seigman, A.E.: Lasers ( Oxford Univ. Press 1986)
5. Maitland, A. and Dunn, M.H. : Laser Physics (N.H.Amsterdam, 1969).
6. Hecht, J.The laser Guide book (McGraw Hill, NY, 1986).

7. Demtroder, W. : Laser Spectroscopy (Springe series in chemical physics vol.5, Springe verlag, Berlin, 1981).
8. Harper, P.G. and Wherrett B.S. (Ed.): Non-linear-optics (Acad. press, 1977).

## **P605: Nonlinear Dynamics and Chaos**

### **UNIT-I**

Dynamical Systems, phase portraits, vector fields, nullclines, flows, discrete dynamical systems, 1-d maps. Fixed points, linearization of vector fields, canonical forms, generalized eigenvectors, semisimple – nilpotent decomposition, Jordan canonical form.

### **UNIT-II**

Classification of fixed points. Hartman -Grobman theorem, homeomorphism, Stable Manifold Theorem, Centre Manifold Theorem, examples of manifolds. Index theory, Lyapunov functions and stability analysis, Limit cycles, Poincare-Bendixon Dynamical Systems, phase portraits, vector fields, nullclines, flows, discrete dynamical systems, 1-d maps, Fixed points.

### **UNIT-III**

Linearization of vector fields, canonical forms, generalized eigen vectors, semisimple-nilpotent decomposition, Jordan canonical form, classification of fixed points. Hartman-Grobman theorem, homeomorphism, Stable Manifold Theorem, Centre Manifold Theorem, examples of manifolds. Index theory, Lyapunov functions and stability analysis, Limit cycles, Poincare-Bendixon Theorem. Gronwall's inequality.

### **UNIT-IV**

The Variational Equation, exploring neighbourhoods, Lyapunov exponents, Monodromy matrix, Floquet exponents. Bifurcations: Saddle-Node, Transcritical, Pitchfork and Hopf Bifurcation. 1-d maps, linear stability of fixed points and higher order fixed points, chain rule, lyapunov exponent, bifurcation diagram, finding period-n orbits in 1-d maps. 2-d maps, Linearization, the Henon map.

### **UNIT-V**

Poincare surface of section. Symbolic dynamics, Sensitivity to initial conditions, Chaos, Partitions, Transition matrix, Entropies, Smale Horseshoe. Invariant density, the Perron-Frobenius operator. Fractals. Hamiltonian Dynamics.

### **Suggested Texts and References:**

1. Nonlinear Dynamics And Chaos: With Applications To Physics, Biology, Chemistry and Engineering, S. Strogatz, Addison-Wesley 2001
2. Chaos: An Introduction to Dynamical Systems, K.T. Aligood, T.D. Sauer, J.A. Yorke, Springer 2000
3. Differential Equations, Dynamical Systems and an Introduction to Chaos, M. Hirsh, S. Smale and R. Devaney, Elsevier Academic Press, 2012
4. Chaos and Integrability in Nonlinear Dynamics: An Introduction, M. Tabor, John Wiley & Sons, 1989
5. Chaos: Classical and Quantum, P. Cvitanovic *et al.*

### **H601: Ethics of Science and IPR**

Introduction to a Collective, Participatory Teaching-learning Program: A Science of Our own. Science Stands the Test of Ethics ... Some indicators. Levels of Moral Development - Does it mean anything? Medical Ethics: Different themes pertaining to medical ethics including ethical

issues in public health. History, Philosophy and Psychology of Ethics: History of Political Economy and Modern Ethics. Environmental Ethics.

Intellectual Property Rights and Associated Issues: History of Patenting. Digitalizing Culture-I: Free Software and Free Culture. Digitalizing Culture-II: Concentration and appropriation of Power by the few as well as Possibility of Distributive Justice.

Journals and Publishers: Monopolistic practices by Academic Publishers. Quest for Determining what is Virtuous: Ethics in Practice. Collaborative Projects by the Class. Teaching the Teachers and other Virtuous Inquiries.

### **PL601: Physics Laboratory – VI**

Study of quantum mechanics through acoustic analogue (four sessions); Fourier analysis / synthesis – use of simulation; Study of characteristics of a coaxial cable and determination of speed of electromagnetic waves in the coaxial cable; determination of specific charge ( $e/m$ ) of electron; Study of Faraday rotation and determination of Verdit's constant in a glass material; investigation of chaos in a spring based coupled oscillator system; Introduction to workshop practice (two sessions); Introduction to vacuum practice (two sessions).

### **Suggested Texts and References:**

1. The Art of Experimental Physics, D. W. Preston and D. R. Dietz, Wiley 1991

## **Semester-VII**

### **P701: Fluid Mechanics**

#### **UNIT-I**

Validity of hydrodynamical description. Kinematics of the flow field. Stress-strain relationship. Basic equations governing conservation of mass, momentum & energy.

#### **UNIT-II**

Navier-Stokes equation for viscous flows. Shear and bulk viscosity and radiative diffusivity in fluids. Viscous and thermal boundary layers, Potential flows, Water waves. Kelvin's circulation theorem, Stokes's flow Lubrication theory.

#### **UNIT-III**

Virial theorem in the tensor form. Magnetohydrodynamic flows. Generalized Ohm's law in the presence of Hall current & Ambipolar diffusion, Magneto-gravity-acoustic modes.

#### **UNIT-IV**

Classical hydrodynamic and hydromagnetic linear stability problems: Rayleigh-Taylor and Kelvin- Helmholtz instabilities. Jeans' gravitational instability; Benard convection. Parker instability and magnetic buoyancy. Thermal instability. Non-linear Benard problem.

#### **UNIT-V**

Spherical accretion flows onto compact objects and accretion disks. High Speed flow of gases. Shock waves and blast waves. Supernova hydrodynamics. Physiological hydrodynamics. Blood flow in human heart.

### **Suggested Texts and References:**

1. Hydrodynamics, 6th Edition, H. Lamb, Dover 1945
2. An Introduction to Fluid Dynamics, G.K. Batchelor, Cambridge University Press, 2000
3. Fluid Mechanics, 2nd Edition, L.D. Landau and E.M. Lifshitz, Elsevier 1987



4. Magnetohydrodynamics, 2nd Edition, T.G. Cowling, Hilger 1976
5. Introduction to Physics of Fluids and Solids, J. Trefil, Dover 1975.

### **P702: Quantum Mechanics – III**

#### **UNIT- I**

**Relativistic Equations:** Lorentz transformations, covariant notation, Klein – Gordon equation, difficulties with probability interpretation of one – particle K-G equation; Dirac equation; Properties of  $\gamma$  matrices.

#### **UNIT- II**

Dirac equation in external electromagnetic field; Non – relativistic reduction; Gyrofactor for spin; Lorentz covariance of Dirac equation; Bilinear covariants.

#### **UNIT- III**

**Solutions of Dirac equation:** Plane wave solutions; Negative energy solutions; Hole theoretic interpretation; Spin; Dirac momentum space spinors; Orthonormality and completeness relations; Projection operators for energy, helicity and spin; Trace theorems; Exact solution of Dirac equation for Coulomb potential; Energy levels of Hydrogen atom in Dirac theory; Fine structure splitting; Relativistic corrections and Lamb shift.

#### **UNIT- IV**

**Introduction to quantum field theory:** Lagrangian field theory, symmetry and conservation laws, Klein – Gordon field (real and complex); Covariant commutators, the K-G propagator; Dirac field; Anti-commutation relations, the Fermion propagator; Electromagnetic field; Covariant quantisation, the photon propagator.

#### **UNIT- V**

Feynman rules for QED: Dyson expansion of S – matrix; Feynman diagrams in momentum space, Feynman rules, QED processes in lowest order.

#### **Suggested Texts and References:**

1. Relativistic Quantum Mechanics vol. 1: J. D. Bjorken and S. D. Drell, McGraw-Hill 1998
2. Intermediate Quantum Mechanics, H. A. Bethe and R. W. Jackiew, Perseus Books 1997
3. Quantum Field Theory, 2nd Edition, F. Mandl and G. Shaw, Wiley 2010
4. Advanced Quantum Mechanics, F. Schwabl, Springer 2008

### **P703: Statistical Mechanics – II**

#### **UNIT-I**

Transport theory using the relaxation time approximation; Boltzmann differential equation formulation; examples of the Boltzmann equation method. Stochastic Processes; Random Walk; Auto-catalytic processes.

#### **UNIT-II**

Diffusion equation; Langevin equation; Fokker- Planck equation.

### UNIT-III

Ising Model; mean-field theory; Landau theory of second order phase transition; Peierls argument; the Bethe-Peierls approximation; Kramers-Wannier duality argument; Pade Approximant.

### UNIT-IV

Phase transition and Critical Phenomenon: critical exponents; exponent inequalities; static scaling hypothesis; block spins and the Kadanoff construction.

### UNIT-V

Renormalization Group: Decimation; Migdal-Kadanoff method; general renormalization group prescription; examples. Monte-Carlo Methods in statistical mechanics; Metropolis algorithm; Gillespie method.

### **Suggested Texts and References:**

1. Fundamentals of Statistical and Thermal Physics, F. Reif, McGraw-Hill Book Company
2. Statistical Physics part 1, 3rd Edition, L. D. Landau and E. M. Lifshitz, Elsevier 2008
3. Statistical Mechanics: A Set of Lectures, R. P. Feynman, W. A. Benjamin, Inc. 1998
4. A Modern Course in Statistical Physics, L. E. Reichl, Wiley 2009

### **P704: Reactor Physics.**

#### UNIT- I

**Fission process:** Liquid drop model, fission rate, reactor power, prompt and delayed neutrons, fission gammas, fission products energy balance, photo neutrons. fissile, fertile and fissionable materials. Fission product activity and decay heat after shut down.

**Interaction of Neutrons with Matter:** Production of neutrons and nuclear reactions with thermal and fast neutrons, transmutation.

#### UNIT- II

**Concept of microscopic cross section:** Inelastic and elastic scattering, Maxwell-Boltzmann distribution and its departure Variation of cross-section with energy, fast, resonance and thermal ranges.  $1/v$  law of neutron cross-section, Resonance absorption, Doppler effect. Eta vs E curve, conversion & breeding concepts-Thorium utilization.

**Diffusion of neutrons:** Fick's law and its validity, steady state neutron diffusion equation, concepts of neutron flux and current, interface conditions, diffusion coefficient, diffusion length and extrapolation distance.

#### UNIT- III

**Chain Reaction:** Four Factor formula, conceptual treatment of diffusion of one group neutrons in non multiplying and multiplying media, infinite and effective multiplication factors bare homogeneous reactor-concepts of material and geometric buckling, sub criticality and super criticality, critical mass, non leakage probabilities in bare homogeneous cores, neutron cycle and lifetime in finite and in infinite reactor system.

**Slowing down process:** Neutron slowing down, slowing down power and moderating ratio for moderators. Slowing down with spatial migration, Fermi age concepts, migration length, use of reflectors/blankets, reflector savings.

**Heterogeneous reactors:** Multigroup neutron diffusion with special reference to 2 group approach, Heterogeneous reactors, comparison with homogeneous reactors, unit-cell concepts.

## **UNIT- IV**

**Reactor kinetics:** Time dependent neutron diffusion equation, one group kinetic equation, prompt neutron life time, Point kinetic model to illustrate importance of delayed neutrons, reactor period, reactivity and its units. Fuel burn-up units.

**Neutron Poisons:** Xenon and Samarium Poisons, Xenon loads (operating and post shutdown), Variation of xenon load with power and enrichment. Xenon oscillations and their control.

## **UNIT- V**

**Reactivity coefficients:** Temperature coefficients of reactivity and void coefficient of reactivity, their relevance to reactor safety. techniques to control reactors, typical reactivity balance, long-term burnup, fuel management. Reactor control system – requirements of physics aspects. Reactor shutdown mechanisms and neutron monitoring during operation and shut down. Approach to criticality, physics measurements and calibrations/validations. Reactivity worth measurements of control rods.

### **Research Reactors at Trombay, Indian PHWRs.**

#### **Suggested Texts and References**

1. Nuclear Reactor Engineering: Reactor Systems Engineering, Samuel Glasstone and Alexander Sesonske, 4th Edition, 2012
2. Introduction to Nuclear Engineering, 3rd Ed., John R. Lamarsh and Anthony J. Baratta, 2001.
3. Nuclear Reactor Analysis, James J. Duderstadt and Louis J. Hamilton, 1976
4. Nuclear Energy: An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, 6th Ed., Raymond Murray and Keith E. Holbert, 2008.
5. Fundamentals of Nuclear Reactor Physics, Elmer E. Lewis, 2008.
6. Nuclear Reactor Physics, 2nd Ed., Weston M. Stacy, 2007
7. Nuclear Energy: Principles, Practices and Prospects, David Bodansky, 2008.

### **PL701: Advanced Physics Laboratory – I**

#### **Nuclear Physics**

Spectral features of photoelectric absorption and Compton scattering with scintillation detectors (i) Inorganic: NaI(Tl), BaF<sub>2</sub> (ii) Organic: BC501A and plastic. Energy calibration, energy resolution, photopeak and total efficiency, relative intensity, photoelectric and Compton cross-sections, radiation shielding. Alpha spectroscopy with a silicon surface barrier detector. Fine structure of alpha spectrum and determination of age of source. Fast timing and coincidence measurements using BaF<sub>2</sub> and BC501A detectors. Angular correlation of gamma rays using NaI(Tl) detectors. High resolution, low-energy photon measurements with a silicon drift detector: Internal conversion studies, elemental composition through X-Ray Fluorescence (XRF) analysis. Geiger-Muller counter: operating characteristics, dead time measurement, determination of mass absorption coefficient, verification of inverse square law. Lifetime measurements: from nanoseconds through minutes using fast coincidence and decay studies. High-resolution gamma ray measurements with high-purity germanium detectors. Classic experiments: Rutherford scattering, cloud chamber, beta spectrometer. Spectrum analysis techniques and fitting routines: data/peak fitting, energy and efficiency calibration, 1D and 2D histograms. (Selected experiments from the above list are performed based on number of contact hours prescribed)

#### **Condensed Matter**

Growth of metallic thin films by physical vapor deposition techniques like thermal evaporation and DC magnetron sputtering. Tuning of growth parameters to change the deposition rate and



hence thickness of the films. Introduction to vacuum techniques: vacuum pumps, rotary pump, diffusion pump and turbo molecular pumps. Measurement of vacuum: thermocouple gauges, hot and cold cathode gauges. Thickness measurement of thin films by quartz crystal monitor.

Structural characterization of materials (some known and some unknown) by X-ray diffraction (XRD) and X-ray fluorescence (XRF) (a) Phase identification (b) Chemical composition (c) difference between powder diffraction pattern of single and polycrystalline systems (d) Reasons for line broadening in XRD: Rachinger correction and estimation of particle size from Debye-Scherrer formula. (e) Identifying crystal structure and determination of lattice constant.

**Introduction to low temperature measurements:** operation of a closed cycle cryostat, low temperature thermometers, controlling temperatures using PID feedback using temperature controllers, making electrical contacts on thin films and measuring DC resistance with sourcemeter using four probe method-advantages and disadvantages of the technique, temperature dependent (300-20K) measurement of electrical resistivity of metallic thin films and comparing the room temperature value with the standard. Determination of superconducting transition temperature of a high temperature superconductor using electrical transport measurements. Determination of band gap of a semiconductor: highly doped Si by fitting the temperature dependent resistance to the standard variation in semiconductors. Concepts of measuring electrical resistance in labs: from metals to dielectrics. Introducing GPIB interfacing of electronic instruments with the computer and writing LABVIEW programs to interface temperature controller and sourcemeter.

**Introduction to phase sensitive measurements:** using of a dual phase lock-in amplifier. Measurement of the superconducting transition temperature of a superconducting thin film using a mutual inductance technique down to 2.6K (working of a cryogen free system). Measuring AC resistance of a milliohm resistor using phase sensitive detection and studying the frequency and amplitude variation of the resistance: introduction to noise, White noise and 1/f noise.

### **Suggested Texts and References:**

1. Radiation Detection and Measurement, Glenn F. Knoll, John Wiley 2010
2. Techniques for Nuclear and Particle Physics Experiments: William R. Leo, Springer 1995
3. Basic Vacuum technology, 2nd Edition, A. Chambers, R. K. Fitch and B. S. Halliday, IOP 1998
4. Physical Vapor Deposition, R. J. Hill, McGraw-Hill 2005
5. Elements of X-ray Diffraction, 3rd Edition, B. D. Cullity and S. R. Stock, Prentice Hall 2001
6. Introduction to Solid State Physics, 8th Edition, C. Kittel, Wiley 2012.

## **SEMESTER-VIII**

### **P801: Astronomy and Astrophysics**

#### **UNIT-I**

**Stellar Physics:** Equations governing the structure of stars: Mechanical & Thermal equilibrium. Virial theorem. Modes of energy transfer in stars: radiative & convective transport of energy. Auxiliary input: equation of state, opacity and energy generation by thermonuclear processes. Boundary conditions at the stellar surface & at the centre.

#### **UNIT-II**

Models with linear & quadratic density profiles. Polytopic models. Mass-luminosity-radius relations for low, intermediate & high mass stars. Sources of opacity and nucleosynthesis in stars. Manufacturing of iron-peak and heavier elements by rapid neutron capture processes. Mixing

length theory of convective transport of heat. Completely convective stars. Hertzsprung-Russell diagram. Pre-main sequence contraction and the Hayashi phase. Zero-age main sequence.

### **UNIT-III**

Stellar evolution: main sequence, red giant and asymptotic giant branch. Advanced stages of stellar evolution: white dwarfs, neutron stars & black holes. Physics and astrophysics of collapsed objects: pulsars, X-ray & gamma ray sources. Spherical accretion and Bondi solution. Physics of accretion discs. Stellar rotation and magnetism.

### **UNIT-IV**

**Galactic Physics:** Units in astronomy, co-ordinate system, multi-wavelength sky (radio, IR, Optical, UV, X-ray, Gamma ray), distance ladder, Milkyway Galaxy, interstellar medium, basics of star formation, spiral and elliptical galaxies (morphology, content and kinematics), evidences for dark matter, . astronomy and society (including citizen science), constraints and prospects of astronomy and astrophysics research in India.

### **UNIT-V**

AGNs, evidences for supermassive black holes, M-sigma and similar correlations, radio galaxies, synchrotron radiation, accretion onto black hole, physical processes behind black holegalaxy co-evolution (merger, infall and feedback), clusters of galaxies (contents and kinematics), high redshift galaxies, cosmic evolution of galaxies and black holes, hierarchical structure formation, cosmic-web, GMRT

### **Suggested Texts and References:**

1. The Internal Constitution of Stars, A. S. Eddington, Cambridge University Press, 1988.
2. An Introduction to the Study of Stellar Structure, S.Chandrasekhar, Dover Publications, 2003.
3. The structure & Evolution of the Stars, M.Schwarzschild, Dover Publications, 1962.
4. Cox and Giuli's Principles of Stellar Structure, 2nd Ed., A. Weiss et al., Cambridge, 2003.
5. The Physical Universe: An Introducing to Astronomy, F. H.Shu, University Science Books, 1982.
6. Galactic Astronomy, James Binny and Michael Merrifield, Princeton University Press, 1998.
7. An Introduction to Active Galactic Nuclei, B. M. Peterson, Cambridge University Press, 1997.
8. Extragalactic Astronomy and Cosmology: An Introduction, Peter Schneider, Springer, 2006.
9. Physics of the Interstellar & Intergalactic Medium, Bruce T. Draine, Princeton Univ. Press, 2011.

## **P802: Accelerator Physics and Applications**

### **UNIT-I**

Transverse beam dynamics: Accelerator coordinates; Canonical transformation to accelerators coordinates; Guide field; Dipole and Quadrupole Magnets; Hills equation and solution; Twiss parameters; Matrix formulation; Dispersion; Design of lattices; Field and gradient errors; Chromaticity; sextupole magnets and dynamics aperture.

### **UNIT-II**

Longitudinal beam dynamics: Fields and forces; acceleration by time varying fields; relativistic equations; Overview of acceleration; transit time factor; main RF parameters; momentum compaction factor; transition energy; Equations related to synchrotron; synchronous particle; synchrotron oscillations; principle of phase stability; RF acceleration for synchronous and for non-synchronous particle; small amplitude oscillations; Oscillations with Hamiltonian formalism; limits of stable region; adiabatic damping.

### **UNIT-III**

Linear accelerators: Basic methods of linear acceleration; Fundamental parameters of accelerating structures; Energy gain in linear accelerating structures; Q, Shunt-impedance, transit-time factor; periodic accelerating structures; RFQs; Microwave topics for linacs; Single particle dynamics in linear accelerators; Multi-particle dynamics in linear accelerators.

### **UNIT-IV**

Synchrotron radiation: Introduction to electromagnetic radiation; Radiation of accelerated charged particles; radiation from wigglers and undulators; Electron dynamics with radiation; Low emittance lattices; synchrotron radiation sources.

### **UNIT-V**

Free-electron lasers: Introduction; electron dynamics in the undulator; spontaneous emission; electron dynamics in the laser field; dynamics of the laser field; dimensionless equations of motion; solution in the small-signal, small-gain regime; Madey theorem; three-dimensional effects; undulators; X-ray laser. Advanced accelerator concepts: Photo injectors; laser-wakefield acceleration; plasma-wakefield acceleration; linear colliders; muon colliders.

### **Suggested Texts and References:**

1. An Introduction to the Physics of High-Energy Accelerators, D. A. Edwards & M. J. Syphers
2. An Introduction to Particle Accelerators, Edmund Wilson
3. Introduction to Accelerator Physics, Arvind Jain
4. R. F. Linear Accelerators, T. P. Wangler
5. Classical Electrodynamics, 3rd Edition, J. D. Jackson, Wiley 2012

## **P803: Nuclear and Particle Physics**

### **UNIT-I**

**Nuclear Reactions:** Partial wave decomposition, phase shifts and partial wave analysis of the cross sections in terms of phase shifts. Behaviour of phase shifts in different situations. Black sphere scattering. Optical theorem and reciprocity theorem. Unitarity.

**Optical potential:** Basic definition. Relation between the imaginary part,  $W$  of the OP and  $\sigma_{\text{abs}}$ , and between  $W$  and mean free path. Folding model and a high energy estimate of the OP.

### **UNIT-II**

#### **Categorisation of Nuclear Reaction mechanisms:**

**Low energies:** Discrete region, Continuum Region: (a) Discrete Region: Decaying states. Relation between the width and the mean life time. Energy definition: Lorentzian or Breit-Wigner. Resonance scattering. Derivation of the resonance cross section from phase shift description of cross section. Transmission through a square well and resonances in continuum. Coulomb barrier penetration for charged particles scattering and centrifugal barrier for  $l$  non-zero states. Angular distributions of the particles in resonance scattering. Application to hydrogen burning in stars. (b) Continuum Region: Bohr's compound nucleus model.



### UNIT-III

**Direct Reactions:** Cross section in terms of the T-matrix. Phase space, and its evaluation for simple cases. Lippmann Schwinger equation for the scattering wave function, and its formal solution. On-shell and off-shell scattering. Plane wave and distorted wave approximation to the T-matrix (PWBA, DWBA). Application to various direct reactions like, stripping, pick-up, knock-out etc. High energy scattering. Glauber theory. Eikonal approximation to the scattering wave function. Evaluation of scattering cross section in eikonal approximation. Introduction to heavy-ion scattering and the physics with radioactive ion beams.

### UNIT-IV

**Nuclear Structure:** Generalization of the single-particle shell model, residual interactions, Fermi gas model. Single-particle energies in a deformed potential, shell corrections and the Strutinski method. Pairing: BCS model and the Bogolyubov transformation. Hartree-Fock method: general variational approach, Hartree-Fock equations and applications. Nuclear shape parametrization, quadrupole and higher-order deformations. Collective rotation and vibration; Giant resonances. Cranking model, phenomena at high spin including super-deformation. Introduction to Density-Functional Models, including relativistic mean field. Selected contemporary research topics: Superheavy nuclei; Spectroscopy of drip-line nuclei.

### UNIT-V

**Particle Physics:** Symmetries and conservation laws, conserved quantities in reactions of particles. Relativistic kinematics in particle reactions, invariants, resonances, decays of resonances and their decays etc. Particle classification, mesons and baryons, SU(3) multiplets, quark model. Quarks, gluons, QCD interaction, colour neutrality. Detection of quarks and gluons, structure function in deep inelastic reactions. Quark and lepton families, weak interactions as gauge theory, W and Z bosons. Symmetry breaking and generation of masses, Higgs bosons. Present boundary (strings, grand unification, matter-anti-matter asymmetry, dark matter and energy - seminar, qualitative)

#### **Suggested Texts and References:**

1. Subatomic Physics, E. M. Henley & A. Garcia, World Scientific
2. Concepts of Nuclear Physics, B. C. Cohen, McGraw-Hill.
3. Introduction to Nuclear and Particle Physics, A. Das and T. Ferbel, World Scientific.
4. Structure of the Nucleus: M.A. Preston and R.K. Bhaduri, Levant Books, 2008
5. Nuclear Models: W. Greiner and J.A. Maruhn, Springer, 1996
6. Nuclear Structure from a Simple Perspective: R. F. Casten, Oxford University Press, 1990
7. Theory of Nuclear Structure: M.K. Pal, Affiliated East-West Press, 1982
8. An Introduction to Quarks and Partons, F. E. Close, Academic Press 1980
9. Quarks and Leptons: An Introductory Course in Modern Particle Physics, F. Halzen and A. D. Martin, John Wiley 1984
10. Introduction to High Energy Physics, 4th Edition, D. Perkins, Cambridge 2000

#### **P804: Condensed Matter Physics – II**

### UNIT-I

**Superconductivity:** Revision, Introduction to second quantization, BCS theory, Electron tunneling and energy gap, Josephson effect (AC and DC). GL theory and concept of penetration depth, coherence length and surface energy, Flux quantization.

## **UNIT-II**

Modified London Equation of Mixed Phase, Interaction between Flux tubes, Flux flow, Flux pinning, Magnetization of Mixed State: Bogoliubov transformation, Boundary between normal metal and superconductor, Andreev Reflection and Proximity effect.

## **UNIT-III**

**Magnetism:** Quantum theory of magnetism: Rationalization of the Heisenberg Hamiltonian, Hubbard model and Stoner Model: Derivation of susceptibility, Spin wave using Holstein-Primakov transformation.

## **UNIT-IV**

### **Introduction to Density Functional Theory**

**Introduction to Special topics:** Integer and Fractional Quantum hall effect, unconventional superconductivity, frustrated magnets, Josephson junction qubits, Graphene physics, Topological insulators.

## **UNIT-V**

Kondo Physics, Metamaterials, Physics of photonic band gap materials, quantum cascade lasers, free electron lasers, organic electronics etc.

**Note:** Special topics in Fermi Liquid Theory may be covered if time permits.

### **Suggested Texts and References:**

1. Introduction to Superconductivity, 2nd Edition, M. Tinkham, Dover 2004
2. Superconductivity, J. B. Ketterson and S. N. Song, Cambridge 1999
3. Basic Solid State Physics by A. K. Raychaudhuri
4. Magnetism in Solids, D. H. Martin, Butterworth 1967
5. Quantum theory of Magnetism, 3rd Edition, R. M. White, Springer 2006
6. Electronic Structure, Basic Theory & Practical Methods, R. Martin, Cambridge 2008

## **PL801: Advanced Physics Laboratory – II**

**Introduction to Observational Astronomy:** Transmission of radiation through atmosphere in different bands, need for space platforms for invisible astronomies, Introduction to Optical, Infrared, Ultra-violet, X-ray and Gamma-ray astronomy, what do we measure and learn from different wavebands.

**Introductory Astronomy and Different types of Optical Telescopes:** Astronomical parameters like Apparent and Absolute magnitude, Flux, Luminosity and its dependence on size and temperature of stars, Atmospheric Extinction, Coordinate System in Astronomy Refracting and Reflecting telescopes, different focal plane configurations, their applications and relative merits and demerits. Reflectivity and its wavelength dependence, “seeing” and factors affecting it, use of active and adaptive optics in modern telescopes to overcome atmospheric and thermal effects, calculation of focal length, focal ratio, magnification, field of view, plate scale, diffraction limit of telescopes.

### **Introduction to Focal Plane Detectors for Optical, infrared and UV astronomy:**

Developments and evolution of modern Optical and Infrared imaging detectors: Photographic Plates, Phototubes, Image Intensifiers, Charge Coupled Devices (CCDs), Bolometers and how they work, their characterization and parameters (charge transfer efficiency, quantum efficiency, flat fielding etc.). CCDs uses in Imaging, morphological and Spectroscopic studies, Infrared Detectors and IR Arrays, UV Imaging and Photon Counting Detectors.

**Different types of Focal Plane Instruments:** Imagers, Photometers, Fast Photometers for photon counting, limitations of PMT and CCD based photometers, Importance of spectroscopy, Design and description of Low and High Resolution Spectrometers and their applications, Polarimeters and their applications.

**Interaction of radiation with matter:** (a) Passage of charged and neutral particles through matter, Ionization loss formulae and dependence on different parameters, relativistic rise in ionization loss, detection of neutrons, Bremsstrahlung process, Cerenkov radiation and its application (b) Interaction of photons with matter: Photoelectric interaction, mass absorption formula and dependence on energy, atomic number etc, Thompson scattering, Compton scattering, Pair production process, formula and dependence on energy, atomic number, radiation length, critical energy

**Introduction to Different Types of Gas-Filled Radiation Detectors:** Role of development of new detection techniques in new discoveries in high energy physics and astrophysics, different kind of detection techniques for charged and neutral radiation Dependence of charge multiplication on high voltage and pressure, Townsend coefficient, need for use of inert gases, quench gas, mobility of electrons and ions (a) Ionization Chamber (IC), description of a typical IC, its characteristics, application of IC in physics (b) Proportional Counters (PC): Single and multi cell PCs, filling gases, Penning effect, charge multiplication process, energy resolution of PC, Fano factor, use of PCs in high energy physics, and astronomy especially in X-ray astronomy (c) Geiger Mueller (GM) Counter: Typical GM counter, its characteristics, applications of GM counter

**Scintillation Counters, Cerenkov Detectors and other Solid State Detectors:** Scintillation processes, dependence on energy, charge and atomic number, Photomultiplier (PMT) for detection of light, PMT characteristics, charge multiplication and use of PMTs with scintillators (a) Organic Scintillation Counters: Plastic Scintillators and light yield, their use in charged particle detection, a typical PS detector and its characteristics (b) Inorganic Scintillation Counters: Scintillation medium and need for activators, Sodium Iodide (NaI) and Caesium Iodide detectors, their light output, application of these detectors in physics and astrophysics (c) Silicon detectors and their applications in X-ray Astronomy, Germanium Detectors, Cadmium -Telluride devices and their arrays

**Observational X-ray Astronomy:** Birth and evolution of X-ray Astronomy, different types of X-ray sources, Discovery of X-ray Binaries, their broad properties, optical identification, classification in Low Mass X-ray binaries (LMXBs) and High Mass X-ray Binaries (HMXBs), their unique characteristics, estimation of mass of the compact star in X-ray binaries from the binary parameters (a) Neutron Star Binaries (NSB): X-ray Pulsars in Binaries, Rotation powered pulsars in SNRs, detailed discussion of their timing and spectral properties, New physics and astrophysics learnt from their studies (b) Black Hole Binaries (BHB): Inference about black hole nature, time variability, spectral measurements, mass of black hole

**X-ray Radiation Processes:** (a) Thermal Emission, Black Body emission, Thermal Bremsstrahlung (free-free emission), spectral line formation in thermal plasma, examples of thermal spectra, measurement of temperature and elemental abundances from spectral data (b) Non-thermal Emission: Synchrotron mechanism (magnetic bremsstrahlung), spectral shape, polarized emission, Inverse Compton Scattering, spectrum of radiation, examples of non-thermal spectra, Cyclotron process in strongly magnetized stars and formation of cyclotron lines, determination of magnetic field of the stars



**Experiments to be performed:**

1. Measuring energy resolution (R) of a Cadmium Telluride Detector using X-rays of different energies (E) from radioactive sources and deriving expression for variation of R with E.
2. Solar Constant measurement.
3. Measurement of Solar Limb Darkening.
4. Observing an Optical Binary Star and deriving its light curve.
5. Determine Pulsation period and binary light curve of an accreting Neutron star from X-ray data.
6. Measuring X-ray Energy Spectrum of a Black Hole Binary and fit it with different spectral models.
7. Characteristics of a Proportional Counter and dependence of its energy resolution on different parameters of the PC.

Center for Basic Sciences  
(CBS)

SCHEME OF EXAMINATION  
&

COURSE STRUCTURE  
of

SEMESTER IX and X

M.Sc. Integrated (Physics Stream)  
UNDER

FACULTY OF SCIENCE

Approved by Board of Studies in Physics

EFFECTIVE FROM FEBRUARY 2020



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WEBSITE: -www.prsu.ac.in

Approved by Board of Studies in Physics on 07, January 2020

PT. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR

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**CENTER FOR BASIC SCIENCES**  
**Pt. Ravishankar Shukla University, Raipur**

**SEMESTER-X ( Physics Streams)**

Subject code *	Subject	Subject Contact hrs/per week Theory+Tutorial	Credits
PE1001	Quantum Field Theory	[4 + 1]	5
PE1002	General Relativity and Cosmology	[4 + 1]	5
PE1003	Experimental Techniques	[4 + 1]	5
PE1004	CCD Imaging and Spectroscopy	[4 + 1]	5
PE1005	Biophysics	[4 + 1]	5
PE1006	Particle Physics	[4 + 1]	5

**Min. 20**  
**(Total 240 credits)**

\*Four Subjects will be offered according to the availability of instructors and minimum number of interested students offering a course.

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## Center for Basic Sciences

Pt. Ravishankar Shukla University, Raipur

### PHYSICS STREAM SYLLABUS

### SEMESTER X

#### PE1001 Quantum Field Theory

##### UNIT-I

**Preliminaries:** Why Quantum Field Theory, Creation and annihilation operators, Special relativity, Space and time in relativistic quantum theory, natural units

##### UNIT - II

**Canonical Quantization:** General Formulation. Conjugate Momentum and Quantization. Neutral Scalar Field. Commutation Relations, Normal Ordering, Bose Symmetry, Fock Space. Charged Scalar Field. U(1) Invariance, Charge

Conservation, Particles and Antiparticles. Time Ordered Product, Feynman Propagator for Scalar Fields, Bose- Einstein Distribution, Propagators at Finite Temperature.

##### UNIT - III

**Dirac Field:** The Dirac Equation, Relativistic Covariance. Anti-Commutators. Quantization of the Dirac Field, Electrons and Positrons. Connection between Spin and Statistics. Discrete Symmetries, Parity, Charge Conjugation, Time Reversal, CPT Theorem.

##### UNIT - IV

**Gauge Field:** Gauge Invariance and Gauge Fixing. Quantization of the Electromagnetic Field, Propagator, Vacuum Fluctuations.

##### UNIT - V

**Interacting Theory and Elementary Processes:** Wick's Theorem. Feynman Rules and Feynman Diagrams for Spinor Electrodynamics, Lowest Order Cross-Section for Electron-Electron, Electron-Positron and Electron- Photon Scattering.

##### References:

1. Quantum Field Theory, C. Itzykson and J. B. Zuber, McGraw-Hill Book Co, 1985.
2. Quantum Field Theory, L. H. Ryder, Cambridge University Press, 2008.
3. Field Theory, A Modern Primer, P. Ramond, Benjamin, 1980.
4. The Quantum Theory of Fields, Vol I, S. Weinberg, Cambridge University Press, 1996.

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5. Introduction to The Theory of Quantum Fields, N. N. Bogoliubov and D. V. Shirkov, Interscience, 1960.
6. An Introduction to Quantum Field Theory, M. E. Peskin and D. V. Schroeder, Westview Press, 1995.
7. Quantum Field Theory: Mandl and Shaw
8. A first book of Quantum Field Theory, Amitabha Lahiri, Palash B. Pal, Alpha Science International Ltd., 2000

## PE1002 General Relativity and Cosmology

### UNIT - I

Review of Newtonian Mechanics. Special theory of relativity. Prelude to General relativity, historical developments, 4-Vectors and 4-tensors, examples from physics

### UNIT - II

Principle of Equivalence, Equations of motion, Gravitational force, Tensor Analysis in Riemannian space, Effects of Gravitation, Riemann-Christoffel curvature tensor, Ricci Tensor, Curvature Scalar, Einstein Field Equations, Experimental tests of GT, Scwartzchild Solution,

### UNIT - III

Introduction to Cosmology, The cosmic history and inventory, The expanding Universe

### UNIT- IV

Friedmann Equations and Cosmological Models, The Standard cosmological model, The inflationary Universe, Big-Bang Hypothesis

### UNIT- V

Primordial nucleosynthesis and the thermal history of the Universe. Perturbations in an expanding Universe, Growth of perturbations, Dark Matter Halos

### References:

1. A first course in General Relativity- B. Schutz
2. Gravity: HJ. Hartle
3. The Classical Theory of Fields: Landau and Lifshitz
4. Gravitation and Cosmology: S. Weinberg
5. Introducing Einstein's Relativity: D'Inverno
6. The Early Universe - Kolb and Turner
7. Introduction to Cosmology - Barbara Ryden
4. Modern Cosmology - Scott Dodelson
8. Principles of Physical Cosmology - P.J.E. Peebles
9. Large Scale Structure of the Universe - P.J.E. Peebles
10. Structure Formation in the Universe - T. Padmanabhan

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# PE1004 CCD Imaging and Spectroscopy

## UNIT-I

**Introduction :** Why use CCDs?, CCD manufacturing and operation, CCD operation, CCD types, CCD coatings, Analog-to-digital converters

## UNIT-II

**Characterization of charge-coupled devices:** Quantum efficiency, Charge diffusion, Charge transfer efficiency, Readout noise, Dark current, CCD pixel size, pixel binning, full well capacity, and windowing, Overscan and bias, CCD gain and dynamic range,

## UNIT-III

**CCD imaging, Photometry and astrometry:** Image or plate scale, Flat fielding, Calculation of read noise and gain, Signal-to-noise ratio, Basic CCD data reduction, CCD imaging, Stellar photometry from digital images, Two-dimensional profile fitting, Difference image photometry, Aperture photometry, Absolute versus differential photometry, High speed photometry, PSF shaped photometry, Astrometry, Pixel sampling

## UNIT-IV

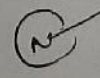
**Review of spectrographs:** CCD spectrographs, CCD spectroscopy, Signal-to-noise calculations for spectroscopy, Data reduction for CCD spectroscopy, Extended object spectroscopy, Slitless spectroscopy

## UNIT-V

**CCDs used in space and at short wavelengths :** CCDs in space, Radiation damage in CCDs, CCDs in the UV and EUV (300–3000 Å) spectral range, CCDs in the X-ray, (<500 Å) spectral range

## References:

1. Handbook of CCD Astronomy, Second edition S. B. Howell
2. Stellar Magnitudes from Digital Pictures, Adams, M., Christian, C., Mould, J., Stryker, L., & Tody, D., 1980, Kitt Peak National Observatory publication.
3. The Next Generation Space Telescope, Bely, P.-Y., Burrows, C., & Illingworth, G. (eds.), 1989, Space Telescope Science Institute publication.
4. Blouke, M., Yang, F., Heidtmann, D., & Janesick, J., 1988, in Instrumentation for Ground-Based Optical Astronomy, ed. L. B. Robinson, Springer-Verlag, p. 462.
5. Bonanno, G., 1995, in New Developments in Array Technology and Applications, eds. A. G. D. Philip, K. A. Janes, & A. R. Upgren, Kluwer, p. 39.
6. Born, M. & Wolf, E., 1959, Principles of Optics, MacMillan, Chap. VIII.
7. Bowen, I. S., 1960a, in Astronomical Techniques, ed. W. A. Hiltner, University of Chicago Press, Chap. 2.
8. Brown, R. (ed.), 1993, The Future of Space Imaging, Space Telescope Science Institute publication, Chap 8.

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## PE1005 Biophysics

### UNIT- I

**Mathematical Methods in Biophysics :** Functions of One Variable and Ordinary Differential Equations, Functions of Several Variables: Diffusion Equation in One Dimension., Random Walks and Diffusion, Random Variables, Probability Distribution, Mean, and Variance , Diffusion Equation in Three Dimensions., Complex Numbers, Complex Variables, and Schrodinger's Equation , Solving Linear Homogeneous Differential Equations., Fourier Transforms, Nonlinear Equations: Patterns, Switches and Oscillators

### UNIT- II

**Quantum Mechanics Basic to Biophysical Methods:** Quantum Mechanics Postulates, . One-Dimensional Problems, The Harmonic Oscillator, The Hydrogen Atom, Approximate Methods, Many Electron Atoms and Molecules , The Interaction of Matter and Light

### UNIT- III

**Computational Modeling of Receptor–Ligand Binding and Cellular Signaling Processes:** Differential Equation-Based Mean-Field Modeling, Application: Clustering of Receptor–Ligand Complexes, Modeling Membrane Deformation as a Result of Receptor–Ligand Binding, Limitations of Mean-Field Differential Equation-Based Modeling, Master Equation: Calculating the Time Evolution of a Chemically Reacting System,

### UNIT- IV

**Stochastic Simulation Algorithms:** Stochastic Simulation Algorithm (SSA) of Gillespie, Application of the Stochastic Simulation Algorithm (SSA), Free Energy-Based Metropolis Monte Carlo Simulation, Application of Metropolis Monte Carlo Algorithm, Stochastic Simulation Algorithm with Reaction and Diffusion: Probabilistic Rate Constant–Based Method, Mapping Probabilistic and Physical Parameters, Modeling Binding between Multivalent Receptors and Ligands, Multivalent Receptor–Ligand Binding and Multi-molecule Signaling Complex Formation, Application of Stochastic Simulation Algorithm with Reaction and Diffusion, Choosing the Most Efficient Simulation Method

### UNIT- V

**Fluorescence Spectroscopy: Fundamental Process of Fluorescence,**

Fluorescence Microscopy, Types of Biological Fluorophores, Application of Fluorescence in Biophysical Research, Dynamic Processes Probed by Fluorescence

**Electrophysiological Measurements of Membrane Proteins :**

Membrane Bioelectricity, . Electrochemical Driving Force, Voltage Clamp versus Current Clamp, Principles of Silver Chloride Electrodes, Capacitive Current and Ionic Current. Gating and Permeation Functions of Ion Channels, Two-Electrode Voltage Clamp for Xenopus Oocyte Recordings , Patch-Clamp Recordings , Patch-Clamp Fluorometry

### References

1. Fundamental Concepts in Biophysics, Thomas Jue

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2. Alon U. 2006. An introduction to systems biology: design principles of biological circuits. Boca Raton: Chapman & Hall.
3. Berg HC. 1993. Random walks in biology. Princeton: Princeton UP.
4. Nelson P. 2004. Biological physics: energy, information and life. New York: W.H. Freeman and Company.
5. Van Kampen NG. 1992. Stochastic processes in physics and chemistry. Amsterdam: North Holland.
6. Shankar R. 1994. Principles of quantum mechanics. New York: Plenum.
7. Cohen-Tannoudji C, Diu B, Laloe F. 1977. Quantum mechanics. Trans SR Hemley, N Ostrowsky, D Ostrowsky, New York: Wiley.
8. Lauffenburger DA, Linderman JJ. 1993. Models for binding, trafficking and signaling. Oxford: Oxford UP.
9. Fall CP, Marland S, Wagner JM, Tyson JJ, eds. 2002. Computational cell biology. New York: Springer

## PE1006 Particle Physics

### UNIT-I

Elementary particles, discrete symmetries and conservation laws, Symmetries and Quarks.

### UNIT-II

Klein-Gordon equation, concept of antiparticle, Lorentz symmetry and scalar / vector / spinor fields.

### UNIT-III

Dirac equation, Scattering processes of spin-1/2 particles (Feynman's rules as thumb rule QFT course), propagators.

### UNIT-IV

Current-current interactions, weak interaction, Fermi theory, Gauge symmetries, spontaneous symmetry breaking, Higgs mechanism

### UNIT-V

Electroweak interaction, Glashow-Salam-Weinberg model, Introduction to QCD, structure of hadrons (form factors, structure functions), parton model, Deep inelastic scattering.

### References:

1. Quarks and Leptons: An Introductory Course in Modern Particle Physics - Francis Halzen, Alan D. Martin
2. Introduction to Elementary Particles, David Griffiths
3. Concepts of Particle Physics, Volume I, Kurt Gottfried and Victor F. Weisskopf, 1986, Oxford University Press,
4. Classical Electrodynamics second edition, J.D. Jackson, 1975, John Wiley & Sons, Inc., (chapters 11 and 12)
5. Introduction to High Energy Physics, fourth edition, Donald H. Perkins, 2000, Cambridge University Press,

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6. Experimental Techniques in High Energy Physics, Thomas Ferbel (editor), 1987, Addison Wesley
7. Gauge Theory of Elementary Particle Physics, Ta-Pei Cheng and Ling-Fong Li, 1984, Oxford University Press
8. Weak Interactions of Leptons and Quarks, E.D. Commins and P.H. Bucksbaum, 1983, Cambridge University Press

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# Center for Basic Sciences

## Pt. Ravishankar Shukla University, Raipur

### Course structure for the M. Sc. (Integrated) Mathematics stream

w.e.f. July 1<sup>st</sup>, 2015

(P: Physics, M: Mathematics, C: Chemistry, B: Biology, G: General, H: Humanity, ME: Math Elective, MPr : Math Project)

### Semester Scheme

There shall be 10 semesters in Integrated M.Sc. Mathematics Course. Five out of thirty elective courses should be taken from the elective courses offered by the School of Mathematical Sciences. Credit points in each semester is indicated in the table below. **Minimum credit points** required to pass each semester is **10**. A total of **minimum 100 credit points** is required to get **M.Sc. degree in Mathematics** from the School of Mathematical Sciences.

Year	Semester	Subjects			Credit Points	Credit Points	Cumulative Credit Points
		Theory	Practical	Project	Min	Max	
1 <sup>st</sup> Year	Sem. I	5(x3)+ 1(x2) = 18	4(x2)= 08	----	10	25	25
	Sem. II	5(x3)+ 1(x2) = 18	4(x2)= 08	----	10	25	50
2 <sup>nd</sup> Year	Sem. III	5(x4)+2(x2)= 24	1(x1)= 01	----	10	25	75
	Sem. IV	5(x4)= 20	1(x4)+1(x1) = 05	----	10	25	100
3 <sup>rd</sup> Year	Sem. V	6(x4)= 24	1(x1)= 02	----	10	25	125
	Sem VI	5(x4)+1(x2)= 22	1(x3)=03	----	10	25	150
4 <sup>th</sup> Year	Sem VII	5(x4) = 20	----	05	10	25	175
	Sem VIII	5(x4) = 20	----	05	10	25	200
5 <sup>th</sup> Year	Sem IX	----	----	20	10	20	220
	Sem X	<u>Elective Papers</u> 5(x4)=20	----	----	10	20	240
<b>Total Credit Points</b>							<b>240</b>
<b>Minimum Credit Points Required to get M.Sc. degree in Mathematics</b>							<b>100</b>

## FIRST YEAR

### **SEMESTER –I**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
B101	Biology – I	[2 + 1]	3
C101	Chemistry – I	[2 + 1]	3
MB101/M101	Mathematics – I	[2 + 1]	3
P101	Physics – I	[2 + 1]	3
G101	Computer Basics	[2 + 1]	3
H101	Communication Skills	[2 + 0]	2
		<b>Lab Hours per Week</b>	
BL101	Biology Laboratory – I	[4]	2
CL101	Chemistry Laboratory – I	[4]	2
PL101	Physics Laboratory – I	[4]	2
GL101	Computer Laboratory	[4]	2
		Semester Credits	<b>25</b>
		Subtotal	<b>25</b>

#### **MB101: Mathematics – 1**

**( For Biology Stream)**

**Unit-I** The idea of derivative of a function, polynomials, slope and tangent line, derivatives of trigonometric functions, product and quotient rules. Notion of limits and continuous functions.

Elementary results pertaining to limits of functions: product and quotient rules. Higher order derivatives, examples. Maxima and minima, curve tracing, Conic sections: circle, ellipse, hyperbola and parabola; equations, focus, directrix, latus rectum. Generalised conic section equation, exponential and logarithmic functions and their derivatives.

**Unit-II** Application of derivatives to root finding: Newton's method (to be supplemented by an introduction to iterative processes). Mean value theorem of differential calculus, Rolle's theorem, applications. l'Hôpital's rule. The chain rule of differentiation, Implicit differentiation, Inverse functions and their derivatives, Inverse trigonometric functions, Applications.

Concept of infinite series, Geometric series, convergence tests; Taylor series, Maclaurin series for elementary functions, power series, simple applications.

**Unit-III** Notion of an integral, integral as limit of sums; anti-derivatives, area under a curve, definite integrals, indefinite integrals. Rules of integration: integration by parts, integration by substitution. Properties of definite integrals including mean value theorem for integral calculus. Fundamental theorem of integral calculus. Integrals involving polynomial, exponential, logarithmic, trigonometric, inverse trigonometric functions. Application of integrals to areas, length of a plane curve, volumes of solids of revolution.



**Unit-IV** Complex numbers: real and imaginary parts, The complex plane, Complex algebra (complex conjugate, absolute value, complex equations, graphs, physical applications). Elementary functions of complex numbers, Euler's formula, Powers and roots of complex numbers. The exponential and trigonometric functions, Hyperbolic functions, Logarithms, Complex roots and powers, Inverse trigonometric and hyperbolic functions, Some applications.

**Unit-V** Separable equations, Linear first order equations, Other methods for first order equations, Second order linear equations with constant coefficients and both zero and non-zero right hand side, Other second order equations.

**Suggested Texts and References:**

- 1) Calculus: Gilbert Strang (MIT Courseware)
- 2) Calculus: M. Weir, J. Hass and F. R. Giordano (Pearson Education)

**M101: Mathematics – I (For Physics, Mathematics & Chemistry Stream)**

**Unit-I Introduction to coordinate geometry:** Equation of a straight line and circle. Introduction to trigonometry (including addition formulas for sine and cosine) through coordinate geometry. AP and GP and inequalities of the mean. Binomial theorem for integer powers.

**Unit-II Complex numbers:** real and imaginary parts, the complex plane, complex algebra (complex conjugate, absolute value, complex equations, graphs, physical applications). Consequences of Euler's formula.

**Unit-III** The idea of derivative of a function, effects of small changes, slope and tangent line, derivatives of polynomials and trigonometric functions, product and quotient rules. Notion of limits and continuous functions. Higher order derivatives, examples. Maxima and minima. Graphical representation of elementary functions such as polynomials, conics, trigonometric functions, exponentials, logarithms and the sawtooth functions. Inverse functions and their graphical representations. Derivatives of exponential, hyperbolic and logarithmic functions. Application of derivatives to root finding: Newton – Raphson method. The chain rule of differentiation, implicit differentiation, inverse functions and their derivatives.

**Unit-IV** Concept of sum of infinite series, geometric series, harmonic series, simple convergence tests. Taylor series, applications to elementary functions, binomial expansion for non-integral powers. Notion of an integral, integral as limit of sums; anti-derivatives, area under a curve, definite integrals, indefinite integrals. Rules of integration: integration by parts, integration by substitution. Properties of definite integrals. Integrals involving elementary functions. Application of integrals to areas and volumes of solids of revolution.

**Unit-V** System of linear equations, notion of a matrix, determinant. Simple properties of matrices and their inverses. Examples of inverting 2X2 and 3X3 matrices. Elementary discussion on scalars and vectors, norm of a vector, dot product, projections, cross product, triple products, applications to areas and volumes.

**Suggested Texts and References:**

1. Calculus, Gilbert Strang (MIT Courseware) <http://ocw.mit.edu/resources/res-18-001-calculus-online-textbook-spring-2005/textbook/>
2. Thomas' Calculus, 11th Edition, M. Weir, J. Hass and F. R. Giordano, Pearson

Education.

3. Mathematical Methods in the Physical Sciences, 3rd Ed., Mary L. Boas, Wiley Student Ed., Wiley India (Reprint) 2009 (for complex numbers and differential equations)
4. Elementary Linear Algebra, 10th Ed., Howard Anton and Chris Rorres, Wiley, 2011.
5. Introduction to Linear Algebra, 4th Edition, Gilbert Strang, Wellesley Cambridge Press, 2009.

## **M101: Mathematics – I (For Physics, Mathematics & Chemistry Stream)**

**Unit I** Numbers, Functions and Sequences: Real Numbers, Functions, Sequences – Convergent, Bounded and Monotone, Limit theorems. Limit and Continuity: Limit of a function at a point, Continuity of functions, Discontinuities of functions, Properties of continuous functions.

Differentiation: Differentiation, Chain rule, Successive differentiation, Rolle 's Theorem and mean value theorem.

**Unit II** Maxima, Minima and Curve Sketching: Sufficient conditions for a function to be increasing/decreasing, Sufficient conditions for a local extremum, Absolute minimum/maximum, Convex/concave functions, Asymptotes, Curve sketching.

Integration: Integral from upper and lower sums, Integral as a limit of Riemann sums, Fundamental theorem of calculus and its applications. Logarithmic and Exponential functions: Logarithmic functions, Exponential functions, Power functions, l'Hôpital's rule. Applications of Integration: Arc length of a plane curve, Arc length of a plane curve in parametric form, Area of a surface of revolution, Volume of a solid of revolution by slicing, by the washer method and by the shell method.

**Unit-III** Limit and Continuity of Scalar Fields: Spaces  $\mathbf{R}^2$  and  $\mathbf{R}^3$ , Scalar fields, level curves and contour lines, Limit of a scalar field, Continuity of a scalar field, Properties of continuous scalar fields.

Differentiation of Scalar Fields: Partial derivatives, Differentiability, Chain rules, Implicit differentiation, Directional derivatives, Gradient of a scalar field, Tangent plane and normal to a surface, Higher order partial derivatives, Maxima and minima, Saddle points, Second derivative test for maxima/minima/saddle points. Vector Fields: Vector fields and their properties, Curves in space, Tangent vector, Basic idea of divergence and curl.

**Unit-IV** Complex Numbers: Real and imaginary parts, The complex plane, Complex algebra (complex conjugate, absolute value, complex equations, graphs, physical applications), Elementary functions of complex numbers, Euler's formula, Powers and roots of complex numbers, The exponential and trigonometric functions, Hyperbolic functions, Logarithms, Complex roots and powers, Inverse trigonometric and hyperbolic functions, Some applications.

**Unit V** Ordinary Differential Equations: Separable equations, Linear first order equations, Other methods for first order equations, Second order linear equations with constant coefficients and both zero and non-zero right hand side, Other second order equations, The Laplace transform, Solution of differential equations by Laplace transforms.

### **Suggested Texts and References:**

1. Calculus @ iitb – Concepts, Examples and Quizzes, Inder K. Rana, Version 2, 2010 (Math4all).
2. Introduction to Real Analysis, 3rd Ed., Robert G. Bartle and Donald R. Sherbert, Wiley
3. Student Ed., Wiley India (4th Reprint) 2007.

4. Mathematical Methods in the Physical Sciences, Mary L. Boas, 3rd Edition, Wiley Student Ed., Wiley India (Reprint) 2009 (for complex numbers and ordinary differential equations).

## SEMESTER –II

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
B201	Biology – II	[2 + 1]	3
C201	Chemistry – II	[2 + 1]	3
MB201/M201	Mathematics – II	[2 + 1]	3
P201	Physics – II (Optics, Electricity & Magnetism)	[2 + 1]	3
G201	Electronics and Instrumentation	[2 + 1]	3
G202	Glimpses of Contemporary Science	[2 + 0]	2
		<b>Contact Hours / Week Laboratory</b>	
BL201	Biology Laboratory	[4]	2
CL201	Chemistry Laboratory	[4]	2
PL201	Physics Laboratory	[4]	2
GL201	Electronics Laboratory	[4]	2
		Semester Credits	<b>25</b>
		Subtotal	<b>50</b>

### MB201: Mathematics – II

( For Biology Stream)

**Unit I** Functions of several variables, partial derivatives, geometric interpretation, properties of partial derivatives, chain rule, applications. Elementary discussion on scalars and vectors, norm of a vector, dot product, projections. Linear equations and matrices, matrix operations. Concept of a determinant, its properties, evaluation of a determinant, cross product as a determinant, lines and planes. Elementary ideas of tensors.

**Unit II** Vector functions. Gradient of a function, geometric interpretation, properties and applications; divergence and curl of a vector function, geometric interpretation, properties and applications; higher derivatives, Laplacian. Line integrals. Double and triple integrals, their properties and applications to areas, volumes, etc.

**Unit III** Gradient theorem, Green's theorem, Stokes' theorem, divergence theorem, applications. Proofs of Stokes' and divergence theorems through physical examples (such as circulation in a 2 dimensional plane and accumulation of fluid in a given volume).

**Unit IV** Curvilinear coordinate systems, spherical and cylindrical coordinates, area and volume elements, illustrations. Gradient, divergence and curl in curvilinear coordinate systems.

**Unit V** Introduction to linear algebra. Vector spaces, linear dependence and independence, notion of basis, and dimension, subspaces. Examples. More on matrices: special kinds of matrices, their properties.



Eigenvalues and eigenvectors, secular determinant, characteristic polynomial. Eigenvalues and eigenvectors of a real symmetric matrix. Illustrative examples. Applications of linear algebra.

### **Suggested Texts and References (for M100 and M200)**

- 1) Calculus: Gilbert Strang (MIT Courseware)
- 2) Calculus: Thomas
- 3) Elementary Linear Algebra: Howard Anton and Chris Rorres
- 4) Introduction to Linear Algebra: Gilbert Strang (MIT Courseware)
- 5) Mathematical Methods for Scientists and Engineers: George B. Arfken and Hans J. Weber (for curvilinear coordinates, beta and gamma functions only)

### **M201: Mathematics – II (For Physics & Chemistry Stream)**

**Unit I** Differential equations: separable equations, first order differential equations. Second order differential equations and Wronskian; equations with constant coefficients, homogeneous and inhomogeneous equations.

**Unit II** Scalar functions of several variables, partial derivatives, geometric interpretation (maxima, minima, saddle points), properties of partial derivatives, chain rule, applications. Gradient of a function, geometric interpretation, properties and applications.

**Unit III** Vector functions. Derivatives of a vector function, divergence and curl, geometric interpretation, properties and applications; higher derivatives, Laplacian.

**Unit IV** Spherical and cylindrical coordinates, area and volume elements, illustrations. Gradient and divergence in spherical and cylindrical coordinates.

**Unit V** Line integrals. Double and triple integrals, their properties and applications to areas, volumes, etc. Gradient theorem, divergence theorem, Stokes' theorem, applications. Illustrations from fluid flow and electromagnetism.

### **Suggested Texts and References**

1. Calculus, Gilbert Strang (MIT Courseware) <http://ocw.mit.edu/resources/res-18-001-calculus-online-textbook-spring-2005/textbook/>
2. Thomas' Calculus, 11th Edition, M. Weir, J. Hass and F. R. Giordano, Pearson Education.
3. Mathematical Methods in the Physical Sciences, 3rd Ed., Mary L. Boas, Wiley Student Ed., Wiley India (Reprint) 2009 (for complex numbers and differential equations)
4. Elementary Linear Algebra, 10th Edition, Howard Anton and Chris Rorres, Wiley Student Ed., Wiley 2011.
5. Introduction to Linear Algebra, 4th Edition, Gilbert Strang, Wellesley Cambridge Press, 2009.

### **M201: Mathematics – II (For Physics & Chemistry Stream)**

**Unit I** Algebra of matrices (real numbers and other fields), special matrices (scalar, diagonal, upper and lower triangular, etc.). Linear equations and their matrix representations, row-echelon form, Gauss- Jordan elimination, general and particular solutions, homogeneous equations. Invertible matrices and elementary matrices, computation of inverse using elementary row operations. Determinants and their properties, minors and cofactors, determinant of a product of matrices, adjoint of a matrix, invertible matrices and determinants. Cramer's rule. Rank of a

matrix, rank and invertibility. Vector spaces (real numbers and other fields). Examples including the space of polynomials, the space of functions, the solution space of a system of homogeneous linear equations, and row and column spaces of a matrix. Span, linear independence, basis, dimension and its uniqueness.

**Unit II** Linear transformations, isomorphisms, kernel and image, the dimension formula. Eigenvalues and eigenvectors of a square matrix or a linear operator, computation of eigenvalues and eigenvectors, characteristic polynomial, sums and products of eigenvalues, similar matrices, diagonalization.

**Unit III** Review of geometric properties of vectors in  $\mathbf{R}^2$  and  $\mathbf{R}^3$ , dot, cross and scalar triple products, their properties and their geometric interpretation. Vector fields, review of definitions and basic properties of gradient, divergence, directional derivatives, divergence, curl and the Laplace operator. Paths and curves in  $\mathbf{R}^2$  and  $\mathbf{R}^3$ , tangent, velocity, acceleration and force vectors, arc length.

**Unit IV** A brief overview of differentials. Double integrals as limits of Riemann sums and as volumes, their computation as iterated integrals, elementary regions. Triple integrals as limits of Riemann sums, their computation as iterated integrals, elementary regions. Change of variables, the Jacobian determinant, spherical and cylindrical coordinates.

**Unit V** Application of double and triple integrals to finding volume, centre of mass, etc. Line integrals, their dependence on parametrization, their computation, work done. Parametrized surfaces, normal to a surface, surface area, surface integrals and their dependence on parametrization, their computation. Oriented surfaces, statement of Green's theorem and its application to computing the area of a region, statements of Stokes' theorem, and Gauss' divergence theorem. Conservative vector fields.

**Suggested Texts and References:**

1. A Course in Linear Algebra with Applications, 2nd Edition, D. J. S. Robinson, World Scientific 2006.
2. Calculus and Analytic Geometry, 9th Edition, G. B. Thomas and R. L. Finney, Pearson Education 2002.
3. Basic Multivariable Calculus, J. Marsden, A. Tromba and A. Weinstein, Springer (India), 2009.
4. Calculus @ iitb–Concepts, Examples and Quizzes, Inder K. Rana, Version 2, 2010(Math4all).

**M201 : Mathematics II (Calculus and Linear Algebra)**  
**(For Mathematics Stream only)**

**Unit I** Recollection and rigorous treatment of continuity and differentiability of a function of one variable. Riemann integration, proof of the Fundamental Theorem of Calculus. Functions of two and three variables, double and triple integrals.

**Unit II** Line integrals. Parametrized surfaces, oriented surfaces. Stokes Theorem, Gauss Divergence Theorem (both without proof).

**Unit III** Recollection of the algebra of matrices (mainly over the field of real numbers, but mention other fields also), linear equations, row-echelon form, Gauss-Jordan elimination. Determinants, rank of a matrix, rank and invertibility.

**Unit IV** Vector spaces (mainly over the field of real numbers, but mention other fields also), span, linear independence, basis, dimension and its uniqueness (without proof).

**Unit V** Linear transformations, kernel and image, the rank-nullity formula. Eigen values and eigenvectors of a square matrix or a linear operator.

**References**

- [1] D.J.S. Robinson, A Course in Linear Algebra with Applications, World Scientific.
- [2] G. B. Thomas and R.L. Finney, Calculus and Analytic Geometry, 9th ed., Addison-Wesley/Narosa, 1998.
- [3] J. Marsden, A. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer
- [4] Inder K. Rana, Calculus@iitb, Concepts and Examples, Version 1.2, math4all 2009.

**SECOND YEAR**  
**SEMESTER –III**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
M301	Foundations	[3 + 1]	4
M302	Analysis I	[3+ 1]	4
M303	Algebra I	[3 + 1]	4
M304	Discrete Mathematics	[3 + 1]	4
M305	Computational Mathematics I	[3 + 1]	4
H301	World Literature	[2 + 0]	2
H302	History and Philosophy of Science	[2 + 0]	2
		<b>Lab Hours per Week</b>	
GL301	Computation Mathematics Laboratory	[2]	1
		<b>Semester Credits</b>	<b>25</b>
		<b>Subtotal</b>	<b>75</b>

**M301 : Foundations**

**Unit I** Logic: Quantifiers, negations, examples of various mathematical and non-mathematical statements. Exercises and examples.

Set Theory: Definitions, subsets, unions, intersections, complements, symmetric difference, De Morgan's laws for arbitrary collection of sets. Power set of a set.

**Unit II** Relations and maps: Cartesian product of two sets. Relations between two sets. Examples of relations. Definition of a map, injective, surjective and bijective maps. A map is invertible if and only if it is bijective. Inverse image of a set with respect to a map. Relation between inverse images and set theoretic operations. Equivalence relations (with lots of examples). Schroeder-Bernstein theorem.



**Unit III** Finite and Infinite sets: Finite sets, maps between finite sets, proof that number of elements in a finite set is well defined. Definition of a countable set (inclusive of a finite set). Countably infinite and uncountable sets. Examples. Proof that every infinite set has a proper, countably infinite subset. Uncountability of  $P(N)$ .

**Unit IV** Partially Ordered Sets: Concept of partial order, total order, examples. Chains, Zorn's Lemma.

**Unit V** Peano's Axioms. Well-Ordering Principle. Weak and Strong Principles of Mathematical Induction. Transfinite Induction. Axiom of Choice, product of an arbitrary family of sets. Equivalence of Axiom of Choice, Zorn's Lemma and Well-ordering principle.

### Additional Topics (Optional)

- (i) Dedekind's Construction of Real Numbers.
- (ii) Decimal, dyadic, triadic expansions of real numbers.
- (iii) Cantor Sets.

### References

[1] Naive Set Theory, P. Halmos.

[2] Set Theory and Logic, R. Stoll.

A lot of the material can be found in the beginning sections of the following books:

[3] Methods of Real Analysis, R. Goldberg.

[4] Topology, J. Munkres.

[5] Elementary Number Theory, D. Burton.

[6] Real Analysis, Bartle and Sherbert.

## M302 : Analysis I

**Unit I** Real Number System: Concept of a field, ordered field, examples of ordered fields, supremum, infimum. Order completeness of  $\mathbf{R}$ ,  $\mathbf{Q}$  is not order complete. Absolute values, Archimedean property of  $\mathbf{R}$ .  $\mathbf{C}$  as a field, and the fact that  $\mathbf{C}$  cannot be made into an ordered field. Denseness of  $\mathbf{Q}$  in  $\mathbf{R}$ . Every positive real number has a unique positive  $n$ -th root.

**Unit II** Sequences: Sequences, limit of a sequence, basic properties like  $\lim_n(x_n y_n) = (\lim_n x_n)(\lim_n y_n)$ . Bounded sequences, monotone sequences, a monotone increasing sequence bounded above converges to its supremum. Sandwich theorem and its applications. Using the Arithmetic mean-Geometric mean inequality to prove results like  $\lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^n$  and  $\lim_n \left(1 - \frac{1}{n}\right)^n$  and are equal,  $\lim_n \sqrt[n]{n} = 1$  and  $\lim_n a^{\frac{1}{n}} = 1$ . Cauchy's first limit theorem, Cauchy's second theorem.

Subsequences and Cauchy sequences: Every sequence of real numbers has a monotone subsequence. Definition of a Cauchy sequence. Cauchy completeness of  $\mathbf{R}$ ,  $\mathbf{Q}$  is not Cauchy complete.

**Unit III** Infinite Series: Basic notions on the convergence of infinite series. Absolute and conditional convergence. Comparison test, ratio test, root test, alternating series test, Theorem of Dirichlet, Statement of Riemann's rearrangement theorem, Cauchy product of two series. Power series, radius of convergence via examples.

**Unit IV** Continuous functions: Continuity, sequential and neighbourhood definitions, basic properties such as sums and products of continuous functions are continuous. Intermediate Value Theorem, Continuous functions on closed and bounded intervals, Monotone continuous functions, inverse functions, Uniform Continuity, examples and counter-examples.

Differentiable functions: Definition : as a function infinitesimally approximable by a linear map, equivalence with Newton ratio definition, basic properties. One-sided derivatives, The  $O$ ;  $o$  and  $\sim$  notations with illustrative examples. Chain rule with complete proof (using above definition). Local monotonicity, relation between the sign of  $f'$  and local monotonicity. Proofs of Rolle's theorem and the Cauchy-Lagrange Mean value theorem. L'Hospital's rule and applications. Higher derivatives and Taylor's theorem, estimation of the remainder in Taylor's theorem, example:

$$f(x) = \begin{cases} e^{-\frac{1}{x^2}} & x \neq 0 \\ 0 & x = 0 \end{cases} . \text{ Convex functions.}$$

**Unit V Riemann Integration:** Definition via upper and lower Riemann sums, basic properties. Riemann integrability, Thm :  $f: [a, b] \rightarrow \mathbf{R}$  continuous implies  $f$  is Riemann integrable, examples of Riemann integrable functions which are not continuous on  $[a, b]$ . Thm : if  $f: [a, b] \rightarrow \mathbf{R}$  is Riemann integrable then so is  $|f|$  and  $|\int_a^b f(x)dx| \leq \int_a^b |f(x)|dx$ . Cauchy-Schwartz inequality



Improper integrals, power series and elementary functions : Cauchy's condition for existence of improper integrals, test for convergence. Examples :  $\int \frac{\sin x}{x} dx$ ,  $\int \cos x^2 dx$ ,  $\int \sin x^2 dx$  . Power series and basic properties, continuity of the sum, validity of term by term differentiation. Binomial theorem for arbitrary real coefficients. Elementary transcendental functions  $e^x$ ,  $\sin x$ ,  $\cos x$  and their inverse functions,  $\log x$ ,  $\tan^{-1} x$ , Gudermannian and other examples.

## References

- [1] Introduction to Real Analysis : R. Bartle & D. Sherbert, Wiley.  
 [2] A First Course in Analysis : G. Pedrick

## M303 : Algebra I (Groups, rings, fields)

**Unit I** Recollection of equivalence relations and equivalence classes, congruence classes of integers modulo  $n$ . Definition of a group, examples including matrices, permutation groups, groups of symmetry, roots of unity. First properties of a group, laws of exponents, finite and infinite groups.

**Unit II** Subgroups and cosets, order of an element, Lagrange theorem, normal subgroups, quotient groups. Detailed look at the group  $S_n$  of permutations, cycles and transpositions, even and odd permutations, the alternating group, simplicity of  $A_n$  for  $n \geq 5$ .

**Unit III** Homomorphisms, kernel, image, isomorphism, the fundamental theorem of group Homomorphisms. Cyclic groups, subgroups and quotients of cyclic groups, finite and infinite cyclic groups.

**Unit IV** Cayleys theorem on representing a group as a permutation group. Conjugacy classes, centre, class equation, centre of a p-group. Sylow theorems, solvable and nilpotent groups.

**Unit V** Definition of a ring, examples including congruence classes modulo n, ideals and Homomorphisms, quotient rings, polynomial ring in one variable over a ring, units, fields, non-zero divisors, integral domains. Rings of fractions, field of fractions of an integral domain. PID, unique factorization in the ring of integers and in the polynomial ring over a field, Gauss Lemma.

## References

- [1] M. Artin, Algebra, Prentice Hall of India, 1994.
- [2] D.S. Dummit and R.M. Foote, Abstract Algebra, 2nd Ed., John Wiley, 2002.
- [3] N. Jacobson, Basic Algebra II, Hindustan Publishing Corporation, 1983.
- [4] S. Lang, Algebra, 3rd ed. Springer (India) 2004.

## M 304 : Discrete Mathematics

**Unit I** Combinatorics: Permutations and combinations. Linear equations and their relation to distribution into boxes. Distributions with repetitions and non-repetitions. Combinatorial derivation of these formulae. Pigeonhole Principle and applications.

**Unit II** Binomial and multinomial theorems. Inclusion-Exclusion Principle and Applications. Recurrence Relations and Generating Functions. Partitions of a number. Number of partitions. Brief introduction to the combinatorics of Young tableaux.

**Unit III** Graph theory: Vertices and edges. Graphs and special types like complete graph, bipartite graph. Degree of a vertex, weighted graphs. Traveling Salesman's Problem. Koenigsberg Seven-bridge puzzle. Walks, Paths, Circuits.

**Unit IV** Euler Graphs, Hamiltonian Paths and Circuits. Trees and algorithms to find trees in a given graph. Planar Graphs.

**Unit V** Spanning trees and cut sets. Minimal spanning trees and algorithms for their computer implementation: the Kruskal's algorithm. Coloring in graph theory. The four colour problem.

## References

- [1] Richard Stanley, Enumerative Combinatorics.
- [2] Alan Tucker, Applied Combinatorics.
- [3] F. Harary, Graph Theory.
- [4] Narsingh Deo, Graph Theory.

## M305 : Computational Mathematics I

**Unit I** Basics of Spreadsheet Programmes (such as Libreoffice/gnumeric).

**Unit II** Introduction to Mathematica including writing simple programmes.



**Unit III** Detailed exploration of notion of calculus of one variable, and simple multivariable calculus using Mathematica.

**Unit IV** Basic Linear Algebra Using Mathematica.

**Unit V** Numerical Solutions of Linear and Non-linear equations using Mathematica. Developing Programmes for each of these methods.

## References

[1] Selwyn Hollis, CalcLabs with Mathematica for Single Variable Calculus, Fifth Edition.

[2] Selwyn Hollis, CalcLabs with Mathematica for Multivariable Calculus, Fifth Edition.

[3] Kenneth Shiskowski, Karl Frinkle, Principles of Linear Algebra with Mathematica.

## H301 : World Literature

**Unit I** What is literature? - A discussion; introduction to literary terms, genres, and forms of various periods, countries, languages, etc.

**Unit II** The novel: Class study of 'Brave New World' by Aldous Huxley; group discussions and student presentations on other genres such as the graphic novel, detective fiction, children's literature, etc.

**Unit III** Plays: Introduction to the history of theatre, class study of (mainly) two plays: 'Pygmalion' by G. B. Shaw and 'Fire and Rain' by Girish Karnad, the setting up of a play-reading group through which the students can be introduced to several other plays.

**Unit IV** Poetry: Brief introduction, study of poetic genres, forms, topics, figures of speech, poetic language, etc. by analyzing various poems from around the world. Short stories, essays, and other types of writing by various authors.

**Unit V** Screening of films based on literary works, such as Pygmalion (My Fair Lady), Fire and Rain (Agnivarsha), Persepolis (a graphic novel), and many others.

## SEMESTER –IV

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
M401	Analysis II	[3 + 1]	4
M402	Algebra II	[3+ 1]	4
M403	Elementary Number Theory	[3 + 1]	4
M404	Topology I	[3 + 1]	4
G401	Statistical Techniques and Applications	[3 + 1]	4

		<b>Lab Hours per Week</b>	
GL401	Computational Laboratory & Numerical Methods	[8]	4
GL402	Statistical Techniques Laboratory	[2]	1
		<b>Semester Credits</b>	<b>25</b>
		<b>Subtotal</b>	<b>100</b>

### **M401 : Analysis II (Multivariable Calculus)**

**Unit I** Linear maps from  $\mathbf{R}^n$  to  $\mathbf{R}^m$ , Directional derivative, partial derivative, total derivative, Jacobian, Mean value theorem and Taylors theorem for several variables, Chain Rule.

**Unit II** Parametrized surfaces, coordinate transformations, Inverse function theorem , Implicit function theorem, Rank theorem.

**Unit III** Critical points, maxima and minima, saddle points, Lagrange multiplier method.

**Unit IV** Multiple integrals, Riemann and Darboux integrals, Iterated integrals, Improper integrals, Change of variables.

**Unit V** Integration on curves and surfaces, Greens theorem, Differential forms, Divergence, Stokes theorem.

### **References**

- [1] M. Spivak, Calculus on Manifolds.
- [2] W. Fleming, Functions of Several Variables, 2nd Ed., Springer-Verlag, 1977.
- [3] J.E.Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus.
- [4] W. Rudin, Principles of Mathematical Analysis, 3rd ed., McGraw-Hill, 1984.
- [5] A Modern Approach to Classical Theorems of Advanced Calculus, W. A. Benjamin, Inc., 1965.

### **M402 : Algebra II (Linear Algebra)**

**Unit I** Modules over a commutative ring, submodules and quotient modules, generators, homomorphisms, exact sequences, finitely generated free modules.

**Unit II** Vector spaces as modules over a field, subspaces, quotient spaces. Span and linear independence, basis, dimension.

**Unit III** Linear maps and their correspondence with matrices with respect to given bases, change of bases.

**Unit IV** Eigenvalues, eigenvectors, eigenspaces, characteristic polynomial, Cayley-Hamilton.

**Unit V** Bilinear forms, inner product spaces, Gram-Schmidt process, diagonalization, spectral theorem.

**Note:** Jordan and rational canonical forms to be done in M602 in Semester VI as an application of

the structure of finitely generated modules over a PID.

## References

- [1] M. Artin, Algebra, Prentice Hall of India, 1994.
- [2] D.S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley, 2002.
- [3] K. Ho\_man and R. Kunze, Linear Algebra, Prentice Hall, 1992.
- [4] N. Jacobson, Basic Algebra II, Hindustan Publishing Corporation, 1983.
- [5] S. Lang, Algebra, 3rd ed. Springer (India) 2004.

## M403 : Elementary Number theory

**Unit I** Fundamental theorem of arithmetic, divisibility in integers. Prime numbers and infinitude of primes. Infinitude of primes of special types. Special primes like Fermat primes, Mersenne primes, Lucas primes etc. Euclidean algorithm, greatest common divisor, least common multiple.

**Unit II** Equivalence relations and the notion of congruences. Wilson's theorem and Fermat's little theorem. Chinese remainder theorem. Continued fractions and their applications. Primitive roots, Euler's Phi function. Sum of divisors and number of divisors, Möbius inversion.

**Unit III** Quadratic residues and non-residues with examples. Euler's Criterion, Gauss' Lemma. Quadratic reciprocity and applications. Applications of quadratic reciprocity to calculation of symbols.

**Unit IV** Legendre symbol: Definition and basic properties. Fermat's two square theorem, Lagrange's four square theorem.

**Unit V** Pythagorean triples. Diophantine equations and Bachet's equation. The duplication formula.

## References

- [1] D. Burton, Elementary Number Theory.
- [2] Kenneth H. Rosen, Elementary number theory and its applications.
- [3] Niven, Ivan M.; Zuckerman, Herbert S.; Montgomery, Hugh L, An Introduction to the Theory of Numbers.

## M404 : Topology I

**Unit I** Recollection of some set theory, particularly the following topics:

(i) Equipotence of sets, Schroeder-Bernstein theorem, countable and uncountable sets, countability of  $\mathbf{Q}$  and uncountability of  $\mathbf{R}$ :

(ii) Equivalence relations, Zorn's lemma, axiom of choice.

Metric spaces: Definition and basic examples including the following:

(i) The discrete metric on any set.

(ii)  $\mathbf{R}$  and  $\mathbf{R}^n$  with Euclidean metrics, Cauchy-Schwarz inequality, definition of a norm on a finite dimensional  $\mathbf{R}$ -vector space and the metric defined by a norm.

(iii) The set  $\mathbf{C}[0, 1]$  with the metric given by  $\sup |f(t) - g(t)|$  (resp.  $\int_0^1 |f(t) - g(t)| dt$ ).

(iv) Metric subspaces, examples.

**Unit II Topology generated by a metric:** Open and closed balls, open and closed sets, complement of an open (closed) set, arbitrary unions (intersections) of open (closed) sets, finite



intersections (unions) of open (closed) sets, open (closed) ball is an open (closed) set, a set is open if and only if it is a union of open balls, Hausdorff property of a metric space.

Equivalence of metrics, examples, the metrics on  $\mathbf{R}^2$  given by  $|x_1 - y_1| + |x_2 - y_2|$  (resp.  $\max\{|x_1 - y_1|, |x_2 - y_2|\}$ ) is equivalent to the Euclidean metric, the shapes of open balls under these metrics. Limit points, isolated points, interior points, closure, interior and boundary of a set, dense and nowhere dense sets.

**Unit III** Continuous maps:  $\varepsilon - \delta$  definition and characterization in terms of inverse images of open (resp. closed) sets, composite of continuous maps, pointwise sums and products of continuous maps into  $\mathbf{R}$ ; homeomorphism, isometry, an isometry is a homeomorphism but not conversely, uniformly continuous maps, examples.

Complete metric spaces: Cauchy sequences and convergent sequences, a subspace of a complete metric space is complete if and only if it is closed, Cantor intersection theorem, Baire category theorem and its applications, completion of a metric space.

General topological spaces, stronger and weaker topologies, continuous maps, homeomorphisms, bases and subbases, finite products of topological spaces.

**Unit IV** Compactness for general topological spaces: Finite subcoverings of open coverings and finite intersection property, continuous image of a compact set is compact, compactness and Hausdorff property.

Compactness for metric spaces: Bolzano-Weierstrass property, the Lebesgue number for an open covering, sequentially compact and totally bounded metric spaces, Heine-Borel theorem, compact subsets of  $\mathbf{R}$ ; a continuous map from a compact metric space is uniformly continuous.

**Unit V** Connectedness: definition, continuous image of a connected set is connected, characterization in terms of continuous maps into the discrete space  $\mathbf{N}$ , connected subsets of  $\mathbf{R}$ ; intermediate value theorem as a corollary, countable (arbitrary) union of connected sets, connected components,

## References

- [1] E. T. Copson, Metric spaces.
- [2] M. Eisenberg, Topology.
- [3] R.H. Kasriel, Undergraduate topology.
- [4] W. Rudin, Principles of mathematical analysis.
- [5] G. F. Simmons, Topology and modern analysis.
- [6] W. A. Sutherland, Introduction to metric and topological spaces.

## **G401: Statistical Techniques and Applications**

**Unit-I** Purpose of Statistics, Events and Probabilities, Assignments of probabilities to events, Random events and variables, Probability Axioms and Theorems. Probability distributions and properties: Discrete, Continuous and Empirical distributions.

**Unit-II Expected values:** Mean, Variance, Skewness, Kurtosis, Moments and Characteristics Functions. Types of probability distributions: Binomial, Poisson, Normal, Gamma, Exponential, Chi-squared, Log-Normal, Student's t, F distributions, Central Limit Theorem.

**Unit-III Monte Carlo techniques:** Methods of generating statistical distributions: Pseudorandom numbers from computers and from probability distributions, Applications. Parameter inference: Given prior discrete hypotheses and continuous parameters, Maximum likelihood method for parameter inference.

**Unit-IV Error Analysis:** Statistical and Systematic Errors, Reporting and using uncertainties, Propagation of errors, Statistical analysis of random uncertainties, Averaging Correlated/ Uncorrelated Measurements. Deconvolution methods, Deconvolution of histograms, binning-free methods. Least-squares fitting: Linear, Polynomial, arbitrary functions: with descriptions of specific methods; Fitting composite curves.

**Unit-V Hypothesis tests:** Single and composite hypothesis, Goodness of fit tests, P-values, Chi-squared test, Likelihood Ratio, Kolmogorov- Smirnov test, Confidence Interval. Covariance and Correlation, Analysis of Variance and Covariance. Illustration of statistical techniques through hands-on use of computer programs.

**Suggested Texts and References:**

1. Statistics: A Guide to the Use of Statistical Methods in the Physical Sciences, R.J. Barlow, John Wiley 1989
2. The Statistical Analysis of Experimental Data, John Mandel, Dover Publications 1984
3. Data Reduction and Error Analysis for the Physical Sciences, 3rd Edition, Philip Bevington and Keith Robinson, McGraw Hill 2003

**THIRD YEAR  
SEMESTER –V**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
M501	Analysis III	[3 + 1]	4
M502	Algebra III	[3+ 1]	4
M503	Topology II	[3 + 1]	4
M504	Probability Theory	[3 + 1]	4
G501	Earth Science & Energy & Environmental Sciences	[3 + 1]	4
PM501	Numerical Analysis	[3 + 1]	4
		<b>Lab Hours per Week</b>	
PML501	Numerical Methods Laboratory	[2]	1
		<b>Semester Credits</b>	<b>25</b>
		<b>Subtotal</b>	<b>125</b>

**M501 : Analysis III (Measure Theory and Integration)**

**Unit I** Sigma algebra of sets, measure spaces. Lebesgues outer measure on the Real line. Measurable set in the sense of Caratheodory. Translation invariance of Lebesgue measure. Existence of a non-Lebesgue measurable set. Cantor set- uncountable set with measure zero.

**Unit II** Measurable functions, types of convergence of measurable functions. The Lebesgue integral for simple functions, nonnegative measurable functions and Lebesgue integrable function, in general.

**Unit III** Convergence theorems- monotone and dominated convergence theorems. Comparison of Riemann and Lebesgue integrals. Riemanns theorem on functions which are continuous almost everywhere.

**Unit V** The product measure and Fubinis theorem. The  $L^p$  spaces and the norm topology. Inequalities of Hölder and Minkowski. Completeness of  $L^p$  and  $L^\infty$  spaces.

## References

- [1] H.L. Royden, Real Analysis, Pearson Education.
- [2] G. DeBarra, Introduction to Measure Theory, Van Nostrand Reinhold.
- [3] I. K. Rana, An Introduction to Measure and Integration, Narosa.
- [4] H.S. Bear, A Primer on Lebesgue Integration, Academic press.

## M502 : Algebra III (Galois Theory)

**Unit I** Prime and maximal ideals in a commutative ring and their elementary properties.

**Unit II** Field extensions, prime fields, characteristic of a field, algebraic field extensions, finite field extensions, splitting fields, algebraic closure, separable extensions, normal extensions,

**Unit III** Finite Galois extensions, Fundamental Theorem of Galois Theory.

**Unit IV** Solvability by radicals.

**Unit V** Extensions of finite fields.

## References

- [1] M. Artin, Algebra, Prentice Hall of India, 1994.
- [2] D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley, 2002.
- [3] N. Jacobson, Basic Algebra I & II, Hindustan Publishing Corporation, 1983.
- [4] S. Lang, Algebra, 3rd ed. Springer (India) 2004.
- [5] R. Lidl and H. Niederreiter, Introduction to Finite Fields and Their Applications, Cambridge University Press, 1986.

## M503 : Topology II

**Unit I** Review of some notions from Topology I. Basic Separation axioms and first and second countability axioms. Examples.

**Unit II** Products and quotients. Tychonoff's theorem. Product of connected spaces is connected. Weak



topology on  $X$  induced by a family of maps  $f_\alpha: X \rightarrow X_\alpha$  where each  $X_\alpha$  is a topological space. The coherent topology on  $Y$  induced by a family of maps  $g_\alpha: Y_\alpha \rightarrow Y$  where  $Y_\alpha$  are given topological spaces. Examples of quotients to illustrate the universal property such as embeddings of  $\mathbf{RP}^2$  and the Klein's bottle in  $\mathbf{R}^4$ .

**Unit III** Completely regular spaces and its embeddings in a product of intervals. Compactification, Alexandroff and Stone-Cech compactifications.

**Unit IV** Normal spaces and the theorems of Urysohn and Tietze. The metrization theorem of Urysohn.

**Unit V** Local compactness, local connectedness and local path-connectedness and their basic properties. If  $q: X \rightarrow Y$  is a quotient map and  $Z$  is locally compact Hausdorff space then  $q \times \text{id}: X \times Z \rightarrow Y \times Z$  is also a quotient map. Locally finite families of sets and Partitions of unity. Baire Category theorem for locally compact Hausdorff spaces.

## References

- [1] G. F. Simmons, Topology and modern analysis
- [2] W. A. Sutherland, Introduction to metric and topological spaces.
- [3] S. Willard, General Topology, Dover, New York.

## M 504 : Probability Theory

**Unit I** Probability as a measure, Probability space, conditional probability, independence of events, Bayes formula. Random variables, distribution functions, expected value and variance. Standard Probability distributions: Binomial, Poisson and Normal distribution.

**Unit II** Borel-Cantelli lemmas, zero-one laws. Sequences of random variables, convergence theorems, Various modes of convergence. Weak law and the strong law of large numbers.

**Unit III** Central limit theorem: DeMoivre-Laplace theorem, weak convergence, characteristic functions, inversion formula, moment generating function.

**Unit IV** Random walks, Markov Chains, Recurrence and Transience.

**Unit V** Conditional Expectation, Martingales.

## References

- [1] Marek Capinski and Tomasz Zastawniak, Probability through Problems, Springer, Indian Reprint 2008.
- [2] P. Billingsley, Probability and Measure, 3rd ed., John Wiley & Sons, New York, 1995.
- [3] J. Rosenthal, A First Look at Rigorous Probability, World Scientific, Singapore, 2000.
- [4] A.N. Shiriyayev, Probability, 2nd ed., Springer, New York, 1995.
- [5] K.L. Chung, A Course in Probability Theory, Academic Press, New York, 1974.

## SEMESTER –VI

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits

M601	Analysis IV	[3 + 1]	4
M602	Algebra IV	[3+ 1]	4
M603	Differential Geometry & Applications	[3 + 1]	4
M604	Differential Equations & Dynamical Systems	[3 + 1]	4
M605	Computational Mathematics II	[3 + 1]	4
PM601	Ethics of Science and IPR	[2 + 0]	2
		<b>Lab Hours per Week</b>	
PML601	Numerical Methods Laboratory	[6]	3
		<b>Semester Credits</b>	<b>25</b>
		<b>Subtotal</b>	<b>150</b>

### **M601 : Analysis IV (Complex Analysis)**

**Unit I** Complex numbers and Riemann sphere. Mobius transformations.

**Unit II** Analytic functions. Cauchy-Riemann conditions, harmonic functions, Elementary functions, Power series, Conformal mappings.

**Unit III** Contour integrals, Cauchy theorem for simply and multiply connected domains. Cauchy integral formula, Winding number.

**Unit IV** Morera's theorem. Liouville's theorem, Fundamental theorem of Algebra. Zeros of an analytic function and Taylors theorem. Isolated singularities and residues, Laurent series, Evaluation of real integrals.

**Unit V** Zeros and Poles, Argument principle, Rouchs theorem.

#### **References**

- [1] L.Ahlfors, Complex Analysis.
- [2] R.V. Churchill and J. W. Brown, Complex Variables and Applications, International Student Edition,Mc-Graw Hill, 4th ed., 1984.
- [3] B.R. Palka, An Introduction to Complex Function Theory, UTM Springer-Verlag, 1991.

### **M602 : Algebra IV (Rings and Modules: Some Structure Theory)**

**Unit I** Recollection of modules, submodules, quotient modules, homomorphisms.

**Unit II** External and internal direct sums of modules. Tensor product of modules over a commutative ring. Functorial properties of  $\otimes$  and  $\text{Hom}$ .

**Unit III** Definitions and elementary properties of projective and injective modules over a commutative ring.

**Unit IV** Structure of finitely generated modules over a PID. Applications to matrices and linear maps over field: rational and Jordan canonical forms.

**Unit V** Simple modules over a not necessarily commutative ring, modules of finite length, Jordan-Holder Theorem, Schur's lemma.

**(Optional, if time permits)** Semisimple modules over a not necessarily commutative ring, Wedderburn Structure Theorem for semisimple rings.

## References

- [1] M. Artin, Algebra, Prentice Hall of India, 1994.
- [2] D.S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley, 2002.
- [3] N. Jacobson, Basic Algebra I & II, Hindustan Publishing Corporation, 1983.
- [4] S. Lang, Algebra, 3rd ed. Springer (India) 2004.

## M603 : Differential Geometry & Applications

**Unit I** Curvature of curves in  $E^n$ : Parametrized Curves, Existence of Arc length parametrization, Curvature of plane curves, Frennet-Serret theory of (arc-length parametrized) curves in  $E^3$ , Curvature of (arc-length parametrized) curves in  $E^n$ , Curvature theory for parametrized curves in  $E^n$ . Significance of the sign of curvature, Rigidity of curves in  $E^n$ .

**Unit II** Euler's Theory of curves on Surfaces : Surface patches and local coordinates, Examples of surfaces in  $E^3$ , curves on a surface, tangents to the surface at a point, Vector fields along curves, Parallel vector fields, vector fields on surfaces, normal vector fields, the First Fundamental form, Normal curvature of curves on a surface, Geodesics, geodesic Curvature, Christoffel symbols, Gauss' formula, Principal Curvatures, Euler's theorem.

**Unit III** Gauss' theory of Curvature of Surfaces : The Second Fundamental Form, Weingarten map and the Shape operator, Gaussian Curvature, Gauss' Theorema Egregium, Gauss-Codazzi equations, Computation of First/Second fundamental form, curvature etc. for surfaces of revolution and other examples.

**Unit IV** More Surface theory: Isoperimetric Inequality, Mean Curvature and Minimal Surfaces (introduction), surfaces of constant curvature, Geodesic coordinates, Notion of orientation, examples of non-orientable surfaces, Euler characteristic, statement of Gauss-Bonnet Theorem.

**Unit V** Modern Perspective on Surfaces: Tangent planes, Parallel Transport, Affine Connections, Riemannian metrics on surfaces.

## References

- [1] Elementary Differential Geometry : Andrew Pressley, Springer Undergraduate Mathematics Series.
- [2] Elementary Differential Geometry : J. Thorpe, Elsevier.
- [3] Differential Geometry of Curves and Surfaces : M. do Carmo.
- [4] Elements of Differential Geometry : R. Millman & G. Parker.

## M604 : Differential Equations & Dynamical Systems

**Unit I** Basic existence and uniqueness of systems of ordinary differential equations satisfying the Lipschitz's condition. Examples illustrating non-uniqueness when Lipschitz or other relevant conditions are dropped. Gronwall's lemma and its applications to continuity of the solutions with



respect to initial conditions. Smooth dependence on initial conditions and the variational equation. Maximal interval of existence and global solutions. Proof that if  $(a, b)$  is the maximal interval of existence and  $a < 1$  then the graph of the solution must exit every compact subset of the domain on the differential equation.

**Unit II** Linear systems and fundamental systems of solutions. Wronskians and its basic properties. The Abel Liouville formula. The dimensionality of the space of solutions. Fundamental matrix. The method of variation of parameters.

**Unit III** Linear systems with constant coefficients and the structure of the solutions. Matrix exponentials and methods for computing them. Solving the in-homogeneous system. The Laplace transform and its applications.

**Unit IV** Second order scalar linear differential equations. The Sturm comparison and separation theorems and regular Sturm-Liouville problems.

**Unit V** Series solutions of ordinary differential equations and a detailed analytic study of the differential equations of Bessel and Legendre. Dynamical systems and basic notions of dynamical systems such as flows, rectification theorem, rest points and its stability. Liouville's theorem on the preservation of phase volume. First integrals and their applications.

## References

- [1] R. Courant and D. Hilbert, Methods of Mathematical Physics, Volume - I
- [2] W. Hurewicz, Lectures on ordinary differential equations, Dover, New York.
- [3] . F. Simmons, Differential equations with applications and historical notes, McGraw Hill.

## **M605 : Computational Mathematics II**

**Unit I** Introduction to SAGE. Using SAGE to explore basics notions of Linear algebra, Number theory, Group Theory

**Unit II** Solving linear and non-linear optimization problems using Mathematica. Developing programmes for various numerical optimization techniques.

**Unit III** . Exploration of Galois theory and Finite Fields Using Sage/Singular/Kash etc.

**Unit IV** Basics of discrete mathematics using Sage/Mathematica. Exploring advanced notions of Complex Analysis and Differential Equations using Mathematica.

**Unit V** Applied Linear Algebra using Mathematica, various matrix factorizations and their applications.

### FOURTH YEAR **SEMESTER –VII**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits

M701	Functional Analysis	[3 + 1]	4
M702	Commutative Algebra	[3+ 1]	4
M703	Differential Topology	[3 + 1]	4
M704	Partial Differential Equations	[3 + 1]	4
M705	Representation Theory of Finite Groups	[3 + 1]	4
MPr701	Project		5
		<b>Semester Credits</b>	<b>25</b>
		<b>Subtotal</b>	<b>175</b>

### M701 : Functional Analysis

**Unit I** Normed linear spaces. Riesz lemma. Heine-Borel theorem. Continuity of linear maps. Hahn-Banach extension and separation theorems.

**Unit II** Banach spaces. Subspaces, product spaces and quotient spaces. Standard examples of Banach spaces like  $l^p$ ,  $L^p$ ,  $C([0; 1])$  etc. Uniform boundedness principle. Closed graph theorem. Open mapping theorem. Bounded inverse theorem.

**Unit III** Spectrum of a bounded operator. Eigenspectrum. Gelfand-Mazur theorem and spectral radius formula. Dual spaces. Transpose of a bounded linear map. Standard examples.

**Unit IV** Hilbert spaces. Bessel inequality, Riesz-Schauder theorem, Fourier expansion, Parseval's formula.

**Unit V** In the framework of a Hilbert space: Projection theorem. Riesz representation theorem. Uniqueness of Hahn-Banach extension.

### References

- [1] J.B. Conway, A course in Functional Analysis, Springer-Verlag, Berlin, 1985.
- [2] G. Go-man and G. Pedrick, First course in functional analysis, Prentice-Hall, 1974.
- [3] E. Kreyszig, Introductory Functional Analysis with applications, John Wiley & Sons, NY, 1978.
- [4] B.V. Limaye, Functional Analysis, 2nd ed., New Age International, New Delhi, 1996.
- [5] A. Taylor and D. Lay, Introduction to functional analysis, Wiley, New York, 1980.

### M702 : Commutative Algebra

**Unit I** Prime and maximal ideals in a commutative ring, nil and Jacobson radicals, Nakayamas lemma, local rings.

**Unit II** Rings and modules of fractions, correspondence between prime ideals, localization.

**Unit III** Modules of finite length, Noetherian and Artinian modules. Primary decomposition in a Noetherian module, associated primes, support of a module.

**Unit IV** Graded rings and modules, Artin-Rees, Krull-intersection, Hilbert-Samuel function of a local ring, dimension theory, principal ideal theorem.

**Unit V** Integral extensions, Noethers normalization lemma, Hilberts Nullstellensatz (algebraic and geometric versions).

## References

- [1] M.F Atiyah and I.G MacDonald, Introduction to Commutative Algebra, Addison-Wesley, 1969.
- [2] D. Eisenbud, Commutative Algebra with a view toward algebraic geometry, Springer-Verlag, Berlin, 2003.
- [3] H. Matsumura, Commutative ring theory, Cambridge Studies in Advanced Mathematics No. 8, Cambridge University Press, Cambridge, 1980.
- [4] S. Raghavan, B. Singh and R. Sridharan, Homological methods in commutative algebra, TIFR Math. Pamphlet No.5, Oxford, 1975.
- [5] B. Singh, Basic Commutative Algebra, World Scientific, 2011.

## M703 : Differential Topology

**Unit I** Differentiable functions on  $\mathbf{R}^n$  : Review of differentiable functions  $\mathbf{f} : \mathbf{R}^n \rightarrow \mathbf{R}^m$ , Implicit and Inverse function theorems, Immersions and Submersions, critical points, critical and regular values.

**Unit II** Manifolds: Level sets, sub-manifolds of  $\mathbf{R}^n$ , immersed and embedded sub-manifolds, tangent spaces, differentiable functions between sub-manifolds of  $\mathbf{R}^n$ , abstract differential manifolds and tangent spaces.

**Unit III** Differentiable functions on Manifolds: Differentiable functions  $\mathbf{f} : \mathbf{M} \rightarrow \mathbf{N}$ , critical points, Sard's theorem, non-degenerate critical points, Morse Lemma, Manifolds with boundary, Brouwer fixed point theorem, mod 2 degree of a mapping.

**Unit IV** Transversality: Orientation of Manifolds, oriented intersection number, Brouwer degree, transverse intersections.

**Unit V** Integration on Manifolds: Vector field and Differential forms, integration of forms, Stokes' theorem, exact and closed forms, Poincar Lemma, Introduction to de Rham theory.

## References

- [1] Topology from a Differentiable Viewpoint : J. Milnor.
- [2] Differential Topology : V. Guillemin & A. Pollack.
- [3] Differential Topology : M. Hirsch.

## M704 : Partial Differential Equations

**Unit I** Generalities on the origins of partial differential equations. Generalities on the Cauchy problem for a scalar linear equation of arbitrary order. The concept of characteristics. The Cauchy-Kowalevsky theorem and the Holmgren's uniqueness theorem. The fundamental equations of mathematical physics as paradigms for the study of Elliptic, Hyperbolic and Parabolic equations.

**Unit II** Quasilinear first order scalar partial differential equations and the method of characteristics. Detailed discussion of the inviscid Burger's equation illustrating the formation of discontinuities in finite time. The fully nonlinear scalar equation and Eikonal equation. The Hamilton-Jacobi equation.



**Unit III** Detailed analysis of the Laplace and Poisson's equations. Green's function for the Laplacian and its basic properties. Integral representation of solutions and its consequences such as the analyticity of solutions. The mean value property for harmonic functions and maximum principles. Harnack inequality.

**Unit IV** The wave equation and the Cauchy problem for the wave equation. The Euler-Poisson-Darboux equation and integral representation for the wave equation in dimensions two and three. Properties of solutions such as finite speed of propagation. Domain of dependence and domain of influence.

**Unit V** The Cauchy problem for the heat equation and the integral representation for the solutions of The Cauchy problem for Cauchy data satisfying suitable growth restrictions. Infinite speed of propagation of signals. Example of non-uniqueness. Fourier methods for solving initial boundary value problems.

## References

- [1] R. Courant and D. Hilbert, Methods of Mathematical Physics, Volume - II  
 [2] R. C. McOwen, Partial differential equations, Pearson Education, 2004.

## M705 : Representation Theory of Finite Groups

**Unit I** Recollection of left and right modules, direct sums, tensor products.

**Unit II** Semi-simplicity of rings and modules, Schur's lemma, Maschke's Theorem,

**Unit III** Wedderburn's Structure Theorem. The group algebra.

**Unit IV** Representations of a finite group over a field, induced representations, characters, orthogonality relations.

**Unit V** Representations of some special groups. Burnside's  $p^a q^b$  theorem.

## References

- [1] M. Artin, Algebra, Prentice Hall of India, 1994.  
 [2] M. Burrow, Representation Theory of Finite Groups, Academic Press, 1965.  
 [3] D.S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley, 2002.  
 [4] N. Jacobson, Basic Algebra I & II, Hindustan Publishing Corporation, 1983.  
 [5] S. Lang, Algebra, 3rd ed. Springer (India) 2004.  
 [6] J.P. Serre, Linear Representation of Groups, Springer-Verlag, 1977.

## SEMESTER –VIII

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
M801	Fourier Analysis	[3 + 1]	4
M802	Algebraic Number Theory	[3+ 1]	4

M803	Algebraic Topology	[3 + 1]	4
M804	Stochastic Analysis	[3 + 1]	4
M805	Computational Mathematics III	[3 + 1]	4
MPr801	Project		5
		<b>Semester Credits</b>	<b>25</b>
		<b>Subtotal</b>	<b>200</b>

## M801 : Fourier Analysis

**Unit I** Fourier series. Discussion of convergence of Fourier series.

**Unit II** Uniqueness of Fourier Series, Convolutions, Cesaro and Abel Summability, Fejer's theorem, Dirichlet's theorem, Poisson Kernel and summability kernels. Example of a continuous function with divergent Fourier series.

**Unit III** Summability of Fourier series for functions in  $L^1$ ,  $L^2$  and  $L^p$  spaces. Fourier-transforms of integrable functions. Basic properties of Fourier transforms, Poisson summation formula, Hausdorff-Young inequality, Riesz-Thorin Interpolation theorem.

**Unit IV** Schwartz class of rapidly decreasing functions, Fourier transforms of rapidly decreasing functions, Riemann Lebesgue lemma, Fourier Inversion Theorem, Fourier transforms of Gaussians, Plancherel theorem, Paley-Weiner theorem.

**Unit V** Distributions and Fourier Transforms: Calculus of Distributions, Tempered Distributions: Fourier transforms of tempered distributions, Convolutions, Applications to PDEs.

### References

- [1] Y. Katznelson, Introduction to Harmonic Analysis, Dover.
- [2] R. E. Edwards, Fourier Series, Academic Press.
- [3] E. M. Stein and R. Shakarchi, Fourier Analysis: An Introduction, Princeton University Press, Princeton 2003.
- [4] W. Rudin, Fourier Analysis on groups, Interscience.

## M802 : Algebraic Number Theory

**Unit I** Field extensions and examples of field extensions of rational numbers, real numbers and complex numbers. Monic polynomials, Integral extensions, Minimal polynomial, Characteristic polynomial.

**Unit II** Integral closure and examples of rings which are integrally closed. Examples of rings which are not integrally closed. The ring of integers. The ring of Gaussian integers. Quadratic extensions and description of the ring of integers in quadratic number fields. Units in quadratic number fields and relations to continued fractions.

**Unit III** Noetherian rings, Rings of dimension one. Dedekind domains. Norms and traces. Derive formulae relating norms and traces for towers of field extensions. Discriminant and calculations of the discriminant in the special context of quadratic number fields. Different and its applications.

**Unit IV** Cyclotomic extensions and calculation of the discriminant in this case. Factorization of ideals into prime ideals and its relation to the discriminant. Ramification theory, residual degree and its relation to the degree of the extension. Ramified primes in quadratic number fields.

**Unit V** Ideal class group. Geometric ideas involving volumes. Minkowski's theorem and its application to proving finiteness of the ideal class group. Real and complex embeddings. Structure of finitely generated abelian groups. Dirichlet's Unit Theorem and the rank of the group of units. Discrete valuation rings, Local fields.

## References

- [1] Janusz, Algebraic Number Fields.
- [2] Neukirch, Algebraic Number Theory.
- [3] Marcus, Number Fields.

## M803 : Algebraic Topology

**Unit I** Review of quotient spaces and its universal properties. Examples on  $\mathbf{RP}^n$ , Klein's bottle, Mobius band,  $\mathbf{CP}^n$ ,  $\mathbf{SO}(n, \mathbf{R})$ . Connectedness and path connectedness of spaces such as  $\mathbf{SO}(n, \mathbf{R})$  and other similar examples. Topological groups and their basic properties. Proof that if  $H$  is a connected subgroup such that  $G/H$  is also connected (as a topological space) then  $G$  is connected. Quaternions,  $\mathbf{S}^3$  and  $\mathbf{SO}(3, \mathbf{R})$ . Connected, locally path connected space is path connected.

**Unit II** Paths and homotopies of paths. The fundamental group and its basic properties. The fundamental group of a topological group is abelian. Homotopy of maps, retraction and deformation retraction. The fundamental group of a product. The fundamental group of the circle. Brouwer's fixed point theorem. Degree of a map. Applications such as the fundamental theorem of algebra, Borsuk-Ulam theorem and the Perron Frobenius theorem.

**Unit V** Covering spaces and its basic properties. Examples such as the real line as a covering space of a circle, the double cover  $\eta : \mathbf{S}^n \rightarrow \mathbf{RP}^n$ , the double cover  $\eta : \mathbf{S}^3 \rightarrow \mathbf{SO}(3, \mathbf{R})$ . Relationship to the fundamental group. Lifting criterion and Deck transformations. Equivalence of covering spaces. Universal covering spaces. Regular coverings and its various equivalent formulations such as the transitivity of the action of the Deck group. The Galois theory of covering spaces.

**Unit IV** Orbit spaces. Fundamental group of the Klein's bottle and torus. Relation between covering spaces and Orientation of smooth manifolds. Non orientability of  $\mathbf{RP}^2$  illustrated via covering spaces.

**Unit V** Free groups and its basic properties, free products with amalgamations. Concept of push outs in the context of topological spaces and groups. Seifert Van Kampen theorem and its applications. Basic notions of knot theory such as the group of a knot. Wirtinger's algorithm for calculating the Group of a knot illustrated with simple examples.

## References

- [1] E. L. Lima, Fundamental groups and covering spaces, A. K. Peters, 2003.
- [2] W. Massey, Introduction to algebraic topology. Springer Verlag.

## M804 : Stochastic Analysis



**Unit I** Preliminaries: Martingales and properties. Brownian Motion- definition and construction, Markov property, stopping times, strong Markov property zeros of one dimensional Brownian motion.

**Unit II** Reection principle, hitting times, higher dimensional Brownian Motion, recurrence and transience, occupation times, exit times, change of time, Levys theorem.

**Unit III** Stochastic Calculus: Predictable processes, continuous local martingales, variance and covariance processes.

**Unit IV** Integration with respect to bounded martingales and local martingales, Kunita Watanabe inequality, Ito s formula, stochastic integral, change of variables.

**Unit V** Stochastic differential equations, weak solutions, Change of measure, Change of time, Girsanovs theorem.

## References

- [1] Richard Durrett, Stochastic Calculus A Practical Introduction, CRC Press 1996.
- [2] Karatzas I. and Steven Shreve, Brownian Motion and Stochastic Calculus, Springer.
- [3] Oksendal Bernt, Stochastic Differential Equations, Springer.
- [4] J.Michael Steele, Stochastic Calculus and Financial Applications, Springer, 2000

## **M805 : Computational Mathematics III**

**Unit I** Differential Geometry of curves and surfaces using Mathematica. Exploring Differential Equation and Dynamical System using XPPAUT or some other specialized software.

**Unit II** Design of Experiments and Statistics Quality control using R. Project/Math Modeling problem using any Mathematical Software and developing Mathematica packages for various specific methods.

**Unit III** Exploring solutions of Partial Differential equations using Mathematica. Developing programmes to solve problems numerically.

**Unit IV** Exploring basic Notions of Commutative algebra using Sage/Singular /Kash etc.

**Unit V** Advanced notion of optimization techniques using Mathematica. Project/Math Modeling problem using any Mathematical Software and developing Mathematica packages for various specific methods.

## References

- [1] Alfred Gray, Elsa Abbena, Simon Salamon, Modern Differential Geometry of Curves and Surfaces with Mathematica, Third Edition.

FIFTH YEAR  
**SEMESTER –IX**

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
MPr901	Project		20
		<b>Semester Credits</b>	<b>20</b>
		<b>Subtotal</b>	<b>220</b>

## SEMESTER –X

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
ME1001	Elective 1	[3 + 1]	4
ME1002	Elective 2	[3+ 1]	4
ME1003	Elective 3	[3 + 1]	4
ME1004	Elective 4	[3 + 1]	4
ME1005	Elective 5	[3 + 1]	4
		<b>Semester Credits</b>	<b>20</b>
	<b>Total Credits (with 5 Electives)</b>		<b>240</b>
	<b>Minimum required</b>		<b>240</b>

### Electives

Students shall opt 5 Electives from the 30 Electives offered by School of Mathematical Sciences in the Xth semester

1. Advanced Commutative Algebra & Applications.
2. Advanced Differential Topology.
3. Advanced Numerical Techniques.
4. Combinatorics & Enumeration.
5. Lie Groups & Geometry
6. Topics in Algebraic Geometry.
7. Advanced Algebraic Topology & Applications.
8. Advanced Differential Geometry & Applications.
9. Algebraic curves.
10. Analytic number theory.
11. Class field theory.
12. Coding Theory & Cryptography.
13. Combinatorial Design Theory.
14. Econometrics.
15. Elliptic curves.
16. Financial Mathematics.
17. Finite Fields & Applications.
18. Fluid Mechanics.

19. Fractals & Applications.
20. Geometric algebra.
21. Homological Algebra & Applications.
22. Industrial Mathematics.
23. Introduction to algebraic groups.
24. Mathematical Applications to Engineering.
25. Mathematics & Nano Technology.
26. Modular forms.
27. Operator Theory.
28. Perturbation Theory.
29. Quantum Computing.
30. Wavelet Analysis & Applications.



**Center for Basic Sciences  
(CBS)  
SCHEME OF EXAMINATION  
&  
COURSE STRUCTURE  
Of  
SEMESTER IX and X  
M.Sc. Integrated (Mathematics Stream)  
UNDER  
FACULTY OF SCIENCE  
EFFECTIVE FROM JANUARY 2020**



Center of Basic Science  
Pt. Ravishankar Shukla University  
Raipur (C.G.) 492010  
PH: - 0771-2262864  
WEBSITE: -www.prsu.ac.in

Approved by Board of Studies in Mathematics  
Pt. Ravishankar Shukla University, Raipur (C.G.)

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CENTER FOR BASIC SCIENCES  
Pt. Ravishankar Shukla University, Raipur

5 Year Integrated M.Sc. (Mathematics)  
Under  
Faculty of Science

SEMESTER-X (Mathematics Stream)

Subject		Subject Contact hrs/per week Theory+Tutorial	Credits
ME 1001	Electives I	[4 + 1]	5
ME 1002	Electives II	[4 + 1]	5
ME 1003	Electives III	[4 + 1]	5
ME 1004	Elective IV	[4 + 1]	5
		Total	20

Min. 20  
(Total 240 credits)

\*Four Subjects will be offered according to the availability of instructors and more than 50% of students opting for a course.

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Elective-1: Integrated M.Sc. 10<sup>th</sup> Semester (Mathematics)

Dynamical Systems Using Matlab

**Introduction to Matlab**

**Unit-I:** Arithmetic Operations, built-in-MATH functions, scalar variables, creating arrays, built-in functions for handling arrays, mathematical operations with arrays, script files, two dimensional plots, programming in MATLAB, polynomial, curve fitting, and interpolation, three-dimensional plots.

**Discrete Dynamical Systems**

**Unit-II:** One-dimensional maps, cobweb plot: graphical representation of an orbit, stability of fixed points, periodic points, the family of logistic maps, sensitive dependence on initial conditions, analysis of logistic map, Periodic Windows, Feigenbaum number, chaos in logistic map.

**Unit-III:** higher-dimensional maps, sinks, sources, and saddles, nonlinear maps and the jacobian matrix, stable and unstable manifolds, Lyapunov exponents, Numerical Calculation of Lyapunov Exponent, chaotic orbits. Strange Attractors, Gaussian and Hénon Maps. Julia Sets and the Mandelbrot Set.

**Differential Dynamical Systems**

**Unit-IV:** Differential dynamical systems, existence and uniqueness theorem, phase portraits, vector fields, nullclines, flows, fixed points, linearization of vector fields, planar systems, canonical forms, eigenvectors defining stable and unstable manifolds, phase portraits of linear systems in the plane, linearization and Hartman's theorem, limit cycles, existence and uniqueness of limit cycles in the plane, Lyapunov functions and stability.

**Unit-V:** Nonlinear systems and stability, bifurcations of nonlinear systems, normal forms, multistability and bistability, the Rössler system and chaos, the Lorenz equations, Chua's circuit, and the Belousov-Zhabotinski reaction.

**Books and References:**

1. Dynamical Systems with Applications using MATLAB<sup>®</sup> 2<sup>nd</sup> edition, Stephen Lynch, Springer International Publishing Switzerland 2014.
2. CHAOS: An Introduction to Dynamical Systems, Kathleen T. Alligood Tim D. Sauer James A. Yorke, Springer-Verlag .
3. Nonlinear Dynamics And Chaos: With Applications to Physics, Biology, Chemistry, and Engineering, Steven H. Strogatz, CRC Press Taylor & Francis Group, 2018.
4. Differential Equations, Dynamical Systems, and an Introduction to Chaos, Morris W. Hirsch , Stephen Smale , Robert L. Devaney , Elsevier, 2013.
5. Dynamical Systems with Applications using Mathematica, 2nd edition, Stephen Lynch , Springer International Publishing, 2017.

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Elective-2: Integrated M.Sc. 10<sup>th</sup> Semester (Mathematics)

Mathematical Biology

**Unit- I:** Simple Single Species Models: **Continuous Population Models**, Exponential Growth, The Logistic Population Model, Harvesting in Population Models, Constant-Yield and Constant-Effort Harvesting, Eutrophication of a Lake; A Case Study.

Discrete-Time Metered Models, Systems of Two Difference Equations, Oscillation in Flour Beetle Populations: A Case Study.

**Unit-II:** Continuous Single-Species Population Models with Delays: Models with Delay in Per Capita Growth Rates, Delayed-Recruitment Models, Models with Distributed Delay, Harvesting in Delayed Recruitment Models, Nicholson's Blowflies: A Case Study.

**Unit-III:** Models for Interacting Species: The Lotka-Volterra Equations, The Chemostat Model, Equilibria and Linearization, Qualitative Behavior of Solutions of Linear Systems, Periodic Solutions and Limit Cycles, Species in Competition, Kolmogorov Models, Mutualism, The Spruce Budworm: A Case Study.

The Community Matrix, the Nature of Interactions Between Species, Invading Species and Coexistence.

**Unit-IV:** Harvesting in Two-species Models: Harvesting of Species in Competition, Harvesting of Predator-Prey Systems, Intermittent Harvesting of Predator-Prey Systems, Some Economic Aspects of Harvesting, Optimization of Harvesting Returns, A Nonlinear Optimization Problem, Economic Interpretation of the Maximum Principle.

**Unit-V:** Models for Populations with Age and Spatial Structure: Linear model with age structure, The Method of Characteristics, Nonlinear Continuous Models, Models with Discrete Age Groups, Some Simple Examples of Metapopulation Models, A General Metapopulation Model, A Metapopulation Model with Residence and Travel, The Diffusion Equation, Solution by Separation of Variables, Solutions in Unbounded Regions, Linear Reaction-Diffusion Equations, Nonlinear Reaction-Diffusion Equations, Diffusion in Two Dimensions.

**Books and References:**

1. Mathematical Models in Population Biology and Epidemiology, 2<sup>nd</sup> edition, Fred Brauer, Carlos Castillo-Chavez, Texts in Applied Mathematics 40, Springer, 2012.
2. Elements of Mathematical Ecology, Mark Kot, Cambridge University Press, 2001.
3. Mathematical Biology-I: An Introduction, James D. Murray, Springer, 2002.
4. Mathematical Biology-II: Spatial Models and Biomedical Applications, James D. Murray, Springer, 2003.

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Elective-3: Integrated M.Sc. 10<sup>th</sup> Semester (Mathematics)

Financial Mathematics

**Unit I:** Review Of probability, finite probability space.

**Unit II:** Derivatives security, interest rates, other financial instruments, Arbitrage and pricing, risk less issue, yield curves, mean terms matching and immunization, interest rate models.

**Unit III:** Dependent annual rates of return, random walk and Markov process, stochastic calculus.

**Unit IV:** option pricing, portfolio optimization, Fokker-plank equation, distribution and green functions.

**Unit V:** Feynman-kac formula options, dividends revisited. Exotic options.

**Books and References:**

1. Financial mathematics, Richard Brass, Springer, 2003
2. Mathematics of financial derivatives, Wilmott & Howison, Springer, 2005
3. Hand book of stochastic methods, Gardiner, Wiely, 2000
4. The Mathematics of Financial Derivatives: A Student Introduction, Wilmott, Dewynne and Howison, Cambridge University Press, 1995
5. Futures, and Other Derivatives, 5th ed, Hull, Prentice Hall, 2000

Elective-4: Integrated M.Sc. 10<sup>th</sup> Semester (Mathematics)

Non-linear Analysis

**Unit-I: Calculus in Banach space**

Various form of continuity, geometry in normed spaces and duality mappings, Gateaux and Frechet derivative, properties of derivatives, Taylor theorem, inverse function theorem and implicit function theorem, subdifferential of convex function.

**Unit-II: Monotone operators**

Monotone operators, Maximal monotone operators and its properties, constructive solution of operator equations, subdifferential and monotonicity, some generalization of monotone operator.

**Unit-III: Fixed point theorems**

Banach contraction principle and its generalizations, nonexpansive mappings, fixed point theorem of Brouwer and Schauder. Fixed point theorems for multi-functions, common fixed point theorems, sequence of contractions, generalized contractions and fixed points.

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#### Unit-IV: Applications of monotone operators theory

Introduction, Sobolev space, differential equation, nonlinear differential equations, integral equation, Nonlinear ammerstein integral equation, Generalized Hammerstein integral equation.

#### Unit-V: Applications of fixed point theorems

Application to Geometry of Banach Spaces, Application to System of Linear Equations, Perron-Frobenius, Fundamental Theorem of Algebra, Game Theory and Nash Equilibria, Differential equations, integral equations.

#### Books and References:

1. Some topics in nonlinear analysis, M. C. Joshi and R. K. Bose, Wiley Eastern limited, New Delhi, 1985.
2. An introduction to nonlinear analysis and fixed point theory, H. K. Pathak, Springer, 2018.
3. Nonlinear functional analysis and its applications-I, Fixed point theorem, Zeidler, Springer, Heidelberg, 1986.
4. Nonlinear functional analysis, Akerker, Narosa publishing house, New Delhi.

### Elective-5: Integrated M.Sc. 10<sup>th</sup> Semester (Mathematics)

#### Operations Research

**Unit I** Introduction, Nature and Scope of operations research. Linear Programming: Introduction, Mathematical formulation of the problem, Graphical Solution methods, Mathematical solution of linear programming problem, Slack and Surplus variables. Matrix formulation of general linear programming problems.

**Unit II** The Simplex Method: Simplex algorithm, Computational procedures, Artificial variables, Two phase Simplex Method, Formulation of linear programming problems and its solution by simplex method.

**Unit III** Unrestricted variables, problems of degeneracy, Principle of duality in simplex method, Formation of dual with mixed type of constraints, Solution of primal and dual constraints.

**Unit IV** Elementary queuing and inventory models. Steady-state solutions of Markovian queuing models: M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space, M/G/1.

**Unit V** Game Theory: Introduction, Two persons zero sum games, The maxmin and minimax principles. Graphical Solution: Reduction of game problem to LPP.

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## Books and References:

1. Introduction to Operations Research', Hillier, F.S. and G.J. Lieberman, , 9th Ed.; 2010, McGraw Hill, New York.
2. Operation Research, Kanti Swarup, P K Gupta, Man Mohan, Sultanchand and Sons.
3. Operation Research, Theory and Application, J.K. Sharma, Macmillan India.
4. Linear Programming, N.P. Loomba, Tata Mc-Graw Hill.
5. Operation Research: An Introduction, H.A. Taha, Macmillan India.

## Elective-6: Integrated M.Sc. 10<sup>th</sup> Semester (Mathematics)

### Introduction to Cryptography

#### Unit-I:

**Classical Cryptosystems:** Some Simple Cryptosystems, Monoalphabetic and Polyalphabetic cipher, The Shift Cipher, The Substitution Cipher, The Affine Cipher, The Vigenere Cipher, The Hill Cipher, The Permutation Cipher, Cryptanalysis, Some Cryptanalytic Attacks, Stream ciphers, Synchronous Stream Cipher, Linear Feedback Shift Register (LFSR), Non-Synchronous stream Cipher, Autokey Cipher.

#### Unit-II:

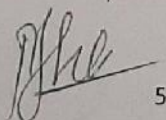
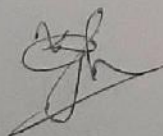
**Block Ciphers:** Mode of operations in block cipher: Electronic Codebook (ECB), Ciphertext Chaining (CBC), Ciphertext FeedBack (CFB), Output FeedBack (OFB), Counter (CTR), DES & AES: The Data Encryption Standard (DES), Feistel Ciphers, Description of DES, Security analysis of DES, Differential & Linear Cryptanalysis of DES, Triple DES, The Advanced Encryption Standard (AES), Finite field GF(28), Description of AES, analysis of AES.

#### Unit-III:

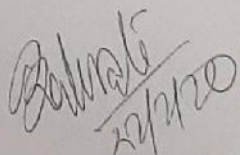
**Shannon's Theory of Perfect Secrecy:** Perfect Secrecy, Birthday Paradox, Vernam One Time Pad, Random Numbers, Pseudorandom Numbers. **Prime Number Generation:** Trial Division, Fermat Test, Carmichael Numbers, Miller Rabin Test, Random Primes.

#### Unit-IV: Public Key Cryptography:

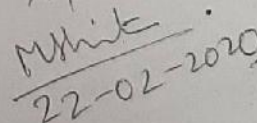
Principle of Public Key Cryptography, RSA Cryptosystem, Factoring problem, Cryptanalysis of RSA, RSA-OAEP, Rabin Cryptosystem, Security of Rabin Cryptosystem, Quadratic Residue Problem, Diffie-Hellman (DH) Key Exchange Protocol, Discrete Logarithm Problem (DLP), ElGamal Cryptosystem, ElGamal & DH, Algorithms for DLP. Elliptic Curve, Elliptic Curve Cryptosystem (ECC), Elliptic Curve Discrete Logarithm Problem (ECDLP).



5



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Mukit  
22-02-2020



### Unit-V: Cryptographic Hash Functions:

Hash and Compression Functions, Security of Hash Functions, Modification Detection Code (MDC), Message Authentication Codes (MAC), Random Oracle Model, Iterated Hash Functions, Merkle-Damgard Hash Function, MD-5, SHA-1, Others Hash Functions.

**Digital Signatures:** Security Requirements for Signature Schemes, Signature and Hash Functions, RSA Signature, ElGamal Signature, Digital Signature Algorithm (DSA), ECDSA, Undeniable Signature, Blind Signature.

### Books and References:

1. J Buchmann, Introduction to Cryptography, Springer (India) 2004
2. S. Padhye, R A Sahu, V Saraswat, Introduction to Cryptography, CRC Press, 2018
3. D R Stinson, Cryptography: Theory and Practice. CRC Press, 2000.
4. Bruce Schenier, Applied cryptography, John Wiley & Sons, 1996.
5. B Forouzan, Cryptography and Network security, Tata McGraw Hill, 2011
6. Wenbo Mao, Modern Cryptography: Theory and Practice. Pearson Education, 2004
7. W Starling, Cryptography and Network security, Pearson Education, 2004.

### Elective-7: Integrated M.Sc. 10<sup>th</sup> Semester (Mathematics)

#### Introduction to Nonlinear Optimization

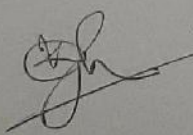
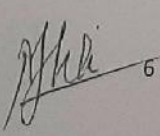
**Unit-I:** Mathematical Preliminaries, the Space  $\mathbb{R}^n$ ,  $\mathbb{R}^{n \times m}$ , Inner Products and Norms, Eigen values and Eigen vectors, Basic Topological Concepts.

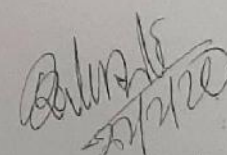
**Unit-II:** Optimality Conditions for Unconstrained Optimization: Global and Local Optima, Classification of Matrices, Second Order Optimality Conditions, Global Optimality Conditions, Quadratic Functions.

**Unit-III:** Least Squares: Solution of over determined Systems, Data Fitting, Regularized Least Squares, Denoising, Nonlinear Least Squares. Descent Directions Methods, The Gradient Method, The Condition Number, Diagonal Scaling, The Gauss-Newton Method, The Fermat-Weber Problem, Convergence Analysis of the Gradient Method.

**Unit-IV:** Newton's Method, Pure Newton's Method, Damped Newton's Method, The Cholesky Factorization. Convex Sets, Algebraic Operations with Convex Sets, The Convex Hull, Convex Cones, Topological Properties of Convex Sets, Extreme Points.

**Unit-V:** Convex Functions, First Order Characterizations of Convex Functions, Second Order Characterization of Convex Functions, Operations Preserving Convexity, Level Sets of Convex Functions, Maxima of Convex Functions, Convexity and Inequalities, Convex Optimization, The Orthogonal Projection Operator, Optimization over a Convex Set, Stationarity in Convex Problems, The Orthogonal Projection Revisited, The Gradient Projection Method, Sparsity Constrained Problems.

  
22-02-2020



## Books and References:

1. Introduction to Nonlinear Optimization Theory, Algorithms, and Applications with MATLAB, Amir Beck, Society for Industrial and Applied Mathematics, 2014.
2. Optimization Theory and Methods: Nonlinear Programming, Wenyu Sun, Ya-Xiang Yuan, Springer, 2006.
3. Nonlinear Optimization, Francisco J. Aragón, Miguel A. Goberna Marco A. López, Margarita M. L. Rodríguez, Springer Undergraduate Texts in Mathematics and Technology, 2019.
4. Nonlinear Optimization: Methods and Applications, H. A. Eiselt, Carl-Louis Sandblom, Springer 2019.

## Elective-8: Integrated M.Sc. 10<sup>th</sup> Semester (Mathematics)

### Complex Network

**UNIT-I:** Fundamentals of Graph Theory; Directed, Weighted and Bipartite Graphs, Trees. Complex Network, Basics, history and importance of Complex Network.

**UNIT-II: Centrality Measures:** The Importance of Being Central, Connected Graphs and Irreducible Matrices, Degree and Eigenvector Centrality, Measures Based on Shortest Paths, Group Centrality.

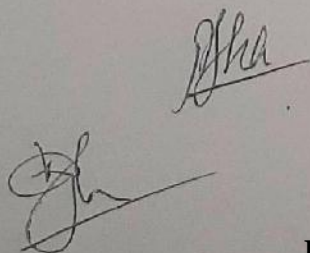
**Unit -III: Random Graphs:** Erdős and Rényi (ER) Models, Degree Distribution, Trees, Cycles and Complete Sub-graphs, Giant Connected Component, Scientific Collaboration Networks, Characteristic Path Length.

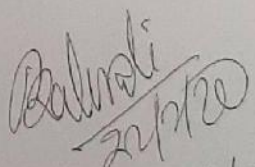
**Unit-IV: Small-World Networks:** Six Degrees of Separation, The Brain of a Worm, Clustering Coefficient, The Watts–Strogatz (WS) Model, Variations to the Theme, Navigating Small-World Networks.

**Unit-V: Generalised Random Graphs:** The World Wide Web, Power-Law Degree Distributions, The Configuration Model, Random Graphs with Arbitrary Degree Distribution, Scale-Free Random Graphs, Probability Generating Functions. Models of Growing Graphs, Degree Correlations.

## Books and References:

1. Complex Networks : Principles, Methods and Applications , Vito Latora , Vincenzo Nicosia , Giovanni Russo , Cambridge University Press, 2017
2. Graph Theory and Complex Networks: An Introduction, Maarten van Steen, Maarten van Steen, 2010.
3. Lectures on Complex Networks, S. N. Dorogovtsev, Clarendon Press Oxford, 2010.
4. The Structure Of Complex Networks: Thoery and Applications, Ernesto Estrada, Oxford University Press, 2011



  
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M. H. K.  
22-02-2020



## CH101

### मूल विज्ञान केन्द्र ,पं. रविशंकर शुक्ल विश्वविद्यालय ,रायपुर (छ.ग.)

#### रचनात्मक हिंदी भाषा

- इकाई I— (1) मानक हिंदी भाषा , वर्तनी लेखन में अशुद्धियों , शब्द शुद्धि, वाक्य शुद्धि, हिंदी भाषा के विकास में हिंदीतर एवं विदेशी विद्वानों का योगदान,  
(2) उसने कहा था , कहानी— चंद्रधर शर्मा गुलेरी ।
- इकाई II— (1) पत्राचार औपचारिक व अनौपचारिक पत्र एवं संप्रेषण कौशल ।  
(2) मनुष्य ही साहित्य का लक्ष्य है । (हजारी प्रसाद द्विवेदी )
- इकाई III— (1) पारिभाषिक शब्दावली की परिभाषा एवं स्वरूप तथा निर्माण की प्रक्रिया (विज्ञान –तकनीकी ), शब्द भंडार ।  
(2) सादगी, सत्य और अहिंसा –मोहनदास करमचंद गांधी (आत्मकथांश)
- इकाई IV— (1) देवनागरी लिपि, वाग्यंत्र और ध्वनि उत्पादन में उनकी भूमिका , स्वर व्यंजन का वर्गीकरण ,IPA अंतरराष्ट्रीय ध्वनि लिपि ।  
(2) नमामि छत्तीसगढ़. (छत्तीसगढ़. का सांस्कृतिक वैभव) : डॉ हीरालाल शुक्ल (आलेख) ।
- इकाई V— (1) अनुवाद , परिभाषा ,प्रक्रिया , अनुवादक के गुण , सफल अनुवाद, हिंदी से अंग्रेजी अनुवाद ।  
(2) योग की शक्ति –डॉ. हरिवंश राय बच्चन (डायरी ) ।  
(3) पृथक छत्तीसगढ़. राज्य –विष्णु खरे (कविता) ।

#### **Suggested Texts and References:**

Sr.No.	Author	Title	Publisher
1.	तिवारी भोलानाथ	हिन्दी भाषा की संरचना	पाण्डूलिपि प्रकाशन ,दिल्ली
2.	प्रसाद वासुदेवनंदन	आधुनिक हिंदी व्याकरण और रचना	भारती भवन प्रकाशन ,पटना
3.	बाहरी हरदेव	पारिभाषिक शब्दावली कोश	राजकमल प्रकाशन दिल्ली
4.	वधान अमरसिंह	भाषा और सूचना प्रौद्योगिकी	भावना प्रकाशन,दिल्ली
5.	गुरु कामता प्रसाद	हिंदी व्याकरण	लोकभारती प्रकाशन ,इलाहाबाद

## ES101-ENVIRONMENTAL STUDIES

### UNIT – I THE MULTI DISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES :

Definition ,scope and importance  
Need for public awareness.

( 5 cr.)

### UNIT-II Natural Resources :

Renewable and non-renewable resources:  
Natural resources and associated problems .

(a) Forest resources : use and over – exploitation, deforestation, case studies, timber extraction, Mining, dams and their effects on forests and tribal people .

(b) Water resources : use and over-utilization of surface and ground water, floods, drought, Conflicts over water , dams benefits and problems .

(c) Mineral resources : use and exploitation, environmental effects of extracting and using Mineral resources, case studies .

(d) Food resources : World food problems , changes caused by agriculture and overgrazing, Effects of modern agriculture , fertilizer –pesticide problems , water logging , salinity Case studies.

(e) Energy resources : Growing energy needs , renewable and non renewable energy sources Use of alternate energy sources ,case studies.

(f) Land resources : land as a resources , land degradation, man induced landslides , soil erosion & desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable life –styles.

(5 cr.)

### UNIT- III Concept of an ecosystems.

Structure and function of an ecosystem.

- Producers , consumers and decomposers .
- Energy flow in the ecosystem .
- Ecological succession.
- Food chains, food webs and ecological pyramids .

(5 cr.)

UNIT-IV Introduction , types ,characteristic features , structure and function of the following

Ecosystem:

- a. Forest ecosystem
- b. Grassland ecosystem
- c. Desert ecosystem
- d. Aquatic ecosystem (ponds , streams, lakes, rivers, oceans,estuaries

(5 cr.)

UNIT- V SOCIAL ISSUES AND THE ENVIRONMENT

- Environment Protection Act.
- Air (prevention and control of pollution) Act.
- Wildlife protection Act.
- Forest conservation Act.
- Issues involved in enforcement of environmental legislation .
- Public awareness.
- Value Education
- HIV/AIDS
- Women and child welfare.
- Role of information technology in Environment and Human Health.
- Case studies.

(5 cr.)

Field work

- Visit to a local area to document environment assets – river / forest/grassland/hill/ Mountain.
- Visit to local polluted site : Urban/Rural/Industrial/Agriculture.

Sr.No.	Author	Title	Publisher
1.	Agarwal K.C.	Environmental Biology 2001	Nidi Publ. Ltd.Bikaner
2.	Bharucha Erach	The Biodiversity of India	Mapin Publishing Pvt. Ltd. Ahmedabad 380013, India .
3.	Bruinner R.C.	Hazardous Waste Incineration, 1989	Mc Graw Hill Inc. 480p.
4.	Bharucha E.	Textbook for Environmental Studies for undergraduate Courses.	UGC, New Delhi & Bharti Vidyapeeth Inst. Of Environment edu. & Research ,Pune.
5.	Begon M.,Town send C.R. ,Harper J.L.	Ecology From Individuals to Ecosystems	4 <sup>th</sup> edition , Blackwell Publishing (TB)

(TB) Textbook.



## **H 101: Communication Skills( COMMON TO ALL BRANCHES)**

### **Unit-I**

An interactive session (with examples) on what is communication, communication in the natural and civilized worlds, types of human communication: visual / non-verbal / verbal, written / spoken, etc

### **Unit-II**

An overview of mass media; a brief discussion of their types (with examples). The concepts of facilitating factors, barriers, and filters in communication; the seven C's of effective communication.

### **Unit-III**

Verbal communication: How to speak / listen effectively (in interpersonal communication), types of publicspeaking, tips for effective public speaking, how to make effective presentations. The role of written text in communication,

### **Unit-IV**

Types of writing (academic/creative/general; formal/informal etc.) with examples of good/bad writing and their analysis. Introduction to letter writing, with stress on formal correspondence; email do's and don'ts.

### **Unit-V**

Academic writing- an overview; explanation of various terms used in academic writing; parts of a paper/thesis;aspects such as formal language, grammatical accuracy, etc. Common grammatical/punctuation errors andhow to avoid them (example-based instruction)

#### **Books Recommended:**

<b>S.No</b>	<b>Author</b>	<b>Book</b>	<b>Publication</b>
<b>1</b>	Rajendra Pal and JS Kurlahalli	Essentials of Business Communication	S.Chand& Sons
<b>2</b>	Michael Alley	The Craft of Scientific Writing (3rd Edition)	Springer, Newyork, 1996
<b>3</b>	Philip Reubens (General editor)	Science and Technical Writing – A Manual of Style (2nd Edition)	Routledge, Newyork, 2001
<b>4</b>	Edmond H. Weiss	Writing Remedies – Practical Exercises for Technical Writing	Universities Press (India) Ltd. , Hyderabad,2000
<b>5</b>	M. Ashraf Rizvi	Effective Technical Communication	Tata Mc Graw – Hill New Delhi, 2005
<b>6</b>	DH Menzel ,HM Jones& LGBoyd	Writing Technical Papers	Mc Graw Hill, 1961
<b>7</b>	KL Turbian	A Manual for Writers of Term Papers Thesis and Dissertation	University of Chicago Press, 1973.

## **ES201: Environmental Studies**

**Unit-I:** Biodiversity and its Conservation: Introduction- Definition: genetics, species and ecosystem diversity. Bio geographical classification of India. Value of biodiversity: consumptive use productive use, social, ethical, aesthetical and option value. Biodiversity at global, National and local levels. India as mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: in situ and ex-situ conservation of biodiversity.

**Unit-II:** Environmental pollution. Definition Causes, effects and control measures of- a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Nuclear hazards.

**Unit-III:** Solid waste management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies Disaster management: floods, earthquake, cyclone and landslides.

**Unit-IV:** Human population and the Environment: Population growth, variation among nation. Population explosion- Family welfare programme. Environment and human health. Human Rights.

**Unit-V:** Social Issues and the Environment: From unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people, its problems and concerns. Case studies. Environment ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products.

## **H201Subject: Communication Skills (Lab)**

Course Outcome: After learning the course the students should be able to

1. To know the process of communication and its components.
2. To improve the language skills i.e. Listening Skills, Speaking Skills, Reading Skills and Writing Skills (LSRW).
3. Construct basic and intermediate skills in English / Hindi language.
4. To enhance phonetic competence, comprehension skills, presentation skills, group discussion skills etc.
5. To build confidence for communicating in English /Hindi and create interest for the life-long learning of English/Hindi language.

### **Unit 1**

Elementary Phonetics (Speech Mechanism. The Description of Speech Sounds, The Phoneme the syllable; Intonation and Word Accent)

Formal (Extempore and Mock Interviews) and Informal Speaking(Situational Dialogues and Role play), Telephoning (Telephonic Conversations)

### **Unit 2**

Paralinguistic features of speaking (voice modulation, pitch, tone, etc.)

Paper Presentation (Non-Technical & current Affairs), Use of Audio-Visual aids: Preparation slides, power point presentation etc.

### **Unit 3**

Body Language(Gestures / Postures during Role Play/Speaking and JAM (Just-a-Minute) Session and Group Discussion

### **Unit 4**

Listening and Comprehending spokenmaterial in Standard Indian English, British English and American English;Exercises on Listening Comprehension,Exercises on Reading Comprehension

Effective Writing (Business Letters, Covering Letter, Resume on Word Document.

Translation and Precis Writing)

### **Unit 5**

Grammar:( English/ Hindi)

Grammar in use: Errors of Accidence and syntax with reference to Parts of Speech;

Agreement of Subject and Verb; Tense and Concord; Use of connectives, Question tags.

Voice and Narration.

Indianism in English: Punctuation and Vocabulary, Building (Antonym, Synonym, Verbal Analogy and One Word Substitution.



## Second Year Semester – III

### H301: World Literature (COMMON TO ALL BRANCHES)

#### Unit-I

What is Literature? - a discussion; Introduction to literary terms, genres, and forms of various periods, countries, languages, etc.

#### Unit-II

The Novel: Class study of 'Brave New World' by Aldous Huxley; Group discussions and student presentations on other genres such as the graphic novel, detective fiction, children's literature, etc.

#### Unit-III

Plays: Introduction to the history of theatre, class study of (mainly) two plays: 'Pygmalion' by G. B. Shaw and 'Fire and Rain' by Girish Karnad, the setting up of play –reading group through which the students can be introduced to several other plays.

#### Unit-IV

Poetry: Brief introduction; Study of poetic genres, forms, topics, figures of speech, poetic language etc. by analysing various poems from around the world

#### Unit-V

Short stories, essays and other types of writing by various authors. Screening of films based on literary works, such as Pygmalion (My Fair Lady), Fire and Rain (Agnivarsha), Persepolis (a graphic novel) and a few others.

#### **Books Recommended:**

S.No	Author	Book	Publication
1	Ifor Ivans London	A Short History of English Literature	London: Penguin Books, 1976
2	Kettle Arnold	An Introduction to English Novel Vol. I, Vol. II	New Delhi: Universal Book store, 1993.
3	Eagleton, Terry.	The English Novel: An Introduction	Oxford: Basil Blackwell. 1983
4	M.H. Abrams)	A Glossary of Literary Terms	Wadsworth Publishing; 10th edition (January 10, 2011
5	J.A. Cuddon	Dictionary of Literary Terms and Literary	(London: Penguin, 2004)
6	Girish Karnad	The Fire and the Rain	New Delhi, Oxford University Press, 1998
7	Aldous Huxley	'Brave New World'	New York: Harper Perennial, 1989
8	G. B. Shaw	Pygmalion	Longman Literature. Harlow: Longman, 1991

मूल विज्ञान केंद्र, पं. रविशंकर शुक्ल विश्वविद्यालय, रायपुर (छ.ग.)  
एम.एस-सी. (इंटीग्रेटेड) तृतीय सेमेस्टर  
प्रयोजनमूलक हिंदी (FH301)  
**Functional Hindi**

- इकाई I-** (1) प्रयोजनमूलक हिंदी का स्वरूप एवं महत्व  
(2) भाषा के विविध रूप— बोली, उपभाषा, राजभाषा, राष्ट्रभाषा, संपर्क भाषा, साहित्यिक भाषा।
- इकाई II-** (1) मीडिया की भाषा— समाचार पत्र, विज्ञापन  
(2) श्रव्य माध्यम, दृश्य—श्रव्य माध्यम
- इकाई III-** (1) पल्लवन— परिभाषा, पल्लवन एवं व्याख्या, आशय कुशल विस्तारक के गुण, सूक्तिपरक वाक्यों का पल्लवन  
(2) झलमला पदुमलाल पुन्नालाल बख्शी कहानी
- इकाई IV-** (1) शब्द रचना— उपसर्ग संस्कृत, हिंदी, उर्दू के उपसर्गों का परिचय  
(2) प्रत्यय—परिभाषा, प्रत्यय के भेद
- इकाई V-** (1) चीफ की दावत — भीष्म साहनी कहानी  
(2) मजदूरी और प्रेम — सरदार पूर्ण सिंह

**संदर्भ ग्रंथ—**

1. प्रयोजनमूलक हिंदी की नयी भूमिका कैलाश नाथ पाण्डेय, लोकभारती प्रकाशन, इलाहाबाद।
2. प्रयोजनमूलक व्यावहारिक हिंदी भाषा कैलाश चंद्र भाटिया, तक्षशिला प्रकाशन, जयपुर।
3. भाषा प्रौद्योगिकी एवं भाषा प्रबंधन सूर्य प्रसाद दीक्षित, किताबघर, नई दिल्ली
4. हिंदी भाषा और संस्कृति म.प्र. हिंदी ग्रंथ अकादमी, भोपाल सं. राजेन्द्र मिश्र
5. कार्यालयी हिंदी, श्री प्रकाशन, रायपुर, प्रो. केशरीलाल वर्मा
6. अच्छी हिंदी, रामचंद्र वर्मा, लोकभारती प्रकाशन, इलाहाबाद (उ.प्र.)
7. अच्छी हिंदी, किशोरी दास वाजपेयी, मीनाक्षी प्रकाशन मेरठ (उ.प्र.)
8. भारतीयता के अमर स्वर प्रधान सं. डॉ. घनंजय वर्मा, म.प्र. हिंदी ग्रंथ अकादमी भोपाल।
9. प्रयोजनमूलक हिंदी डॉ. चितरंजन कर वैभव प्रकाशन रायपुर (छ.ग.)

## **H401Subject: Communication Skills (Lab)**

Course Outcome: After learning the course the students should be able to

1. To know the process of communication and its components.
2. To improve the language skills i.e. Listening Skills, Speaking Skills, Reading Skills and Writing Skills (LSRW).
3. Construct basic and intermediate skills in English / Hindi language.
4. To enhance phonetic competence, comprehension skills, presentation skills, group discussion skills etc.
5. To build confidence for communicating in English /Hindi and create interest for the life-long learning of English/Hindi language.

### **Unit 1**

Elementary Phonetics (Speech Mechanism. The Description of Speech Sounds, The Phoneme the syllable; Intonation and Word Accent)

Formal (Extempore and Mock Interviews) and Informal Speaking(Situational Dialogues and Role play), Telephoning (Telephonic Conversations)

### **Unit 2**

Paralinguistic features of speaking (voice modulation, pitch, tone, etc.)

Paper Presentation (Non-Technical & current Affairs), Use of Audio-Visual aids: Preparation slides, power point presentation etc.

### **Unit 3**

Body Language(Gestures / Postures during Role Play/Speaking and JAM (Just-a-Minute) Session and Group Discussion

### **Unit 4**

Listening and Comprehending spokenmaterial in Standard Indian English, British English and American English;Exercises on Listening Comprehension,Exercises on Reading Comprehension

Effective Writing (Business Letters, Covering Letter, Resume on Word Document. Translation and Precis Writing)

### **Unit 5**

Grammar:( English/ Hindi)

Grammar in use: Errors of Accidence and syntax with reference to Parts of Speech; Agreement of Subject and Verb; Tense and Concord; Use of connectives, Question tags. Voice and Narration.

Indianism in English: Punctuation and Vocabulary, Building (Antonym, Synonym, Verbal Analogy and One Word Substitution.



## **CBS – Five Years Integrated Course, M.Sc. V Semester**

### **Scientific Writing (H501)**

#### **Unit 1**

**Introduction:** What is Scientific Writing; Needs and importance, main features and elements of scientific writing. Tools and types of Scientific Writing , Scientific writing Vs other forms of writing, Different methods of Research, Types of Research.

#### **Unit 2**

**Scientific Writing in Research:** Mechanics of writing. How to write a Research Paper, Project Proposal components of a full length research paper, Research/ Project Report writing, Formulation of Hypothesis, Do's and Don'ts of writing a Research Paper.

#### **Unit 3**

##### **Technical Writing:**

Types of technical documents: Full length research paper, Letters to editor, Book chapter, Review, Conference report, Title/Thesis statement, Abstract/key words, Aims and objectives, Rationale of the paper, Work plan, Materials and methodology, Results and discussion, Key issues and arguments, Acknowledgement, Conflict of interest statement, Reference and Bibliography.

#### **Unit 4**

**Scientometrics:** How to cite and how to do Referencing, Literature Search Technique: using SCOPUS, Google Scholar, PUBMED, Web of Science, Indian Citation Index, and RG Styles of referencing: APA, MLA, Oxford, Harvard, Chicago Annotated bibliography Tools for citing and referencing: Footnote, Endnote etc.

#### **Unit 5**

**Research Paper and Thesis Designing:** Components, Types and Importance Research ethics, Institutional ethics committee, Proof Reading, Studying Peer Review and Impact Factor of Journals, Synopsis Designing, Writing Preface, Acknowledgements, Plagiarism – Pitfall (software to check plagiarism).

**Book Recommended :**

<b>S. No.</b>	<b>Author</b>	<b>Book</b>	<b>Publication</b>
1	Various	The Oxford Book of Modern Science writing	Oxford University Press
2	Robert A. Day and Barbara	How to write and Publish a Scientific paper	Cambridge University Press
3	Angelika Hofmann	Scientific Writing and Communication: Papers Proposals and Presentations	Oxford University Press
4	Jennifer Peat, Elizabeth-Elliott, Louise Baur and Victoria Keena	Scientific Writing: Easy when you know how	BMJ Books
5	Hans F. Ebel, Claus Bliefert, William E. Russey	The Art of Scientific Writing	WILEY-VCH Publishers

## **CBS – Five Years Integrated Course, M.Sc. VI Semester**

### **Scientific Writing Lab / Applications of Scientific Writing (H602)**

**Effective Writing skills:** Structuring Scientific Paper for Journals (Category A, B, C and D) Tables, Figures, Equations and Pictures using Excel, Improving Writing Style, Punctuation, Mechanism of Scientific Writing, Capitalization and Spelling, Collecting, organizing and evaluating data, Making deductions and reading conclusions.

**Project writing:** Technical Resumes & Cover Letters Components of a research proposal: Project summary, Key words, Origin of the proposal, Major Objectives, Methodology, Instrument facility available in the PI's department, Overview of status of Research and Development in the subject, Importance of the proposed project in the context of current status, Bibliography, Making Report of a Project / Research Paper  
Formulation of projects, Funding Agencies: their Templates and Assignments on Project Submission.

**Presentations:** Oral, and Power Point Presentation of Scientific Research Paper in Seminars, Conferences, Research Meetings and gatherings, Audience Analysis in Presentation, Conducting Seminars and Conferences etc.