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 2022 – 23 ONWARDS)

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

(www.prsu.ac.in)

JULY, 2022

Approved on BOS on 29th April 2022

BACHELOR OF VOCATION

RENEWABLE ENERGY TECHNOLOGY & MANAGEMENT

PROGRAMME STRUCTURE

YEAR-1 SEMESTER- I								
MODULE CODE	**NAME**	**L**	**T**	**P**	**CREDIT**	**INTERNAL**	**EXTERNAL**	**TOTAL MARKS**
GENERAL EDUCATION COMPONENT								
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
SKILL COMPONENT								
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
TOTAL					**30**	**1000**		
YEAR-1 SEMESTER-II								
GENERAL EDUCATION COMPONENT								
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

SKILL COMPONENT								
RETM-205	Waste to Energy Conversion 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
TOTAL					**60**	**2000**		

YEAR-2 SEMESTER- III								
MODULE CODE	**NAME**	**L**	**T**	**P**	**CREDIT**	**INTERNAL**	**EXTERNAL**	**TOTAL MARKS**
GENERAL EDUCATION COMPONENT								
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
SKILL COMPONENT								
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

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
TOTAL					**60**	**2000**		

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
YEAR-3 SEMESTER-VI								
GENERAL EDUCATION COMPONENT								
RETM-601	Industrial Training	0	0	20	10	0	350	350
RETM-602	Major Project	0	0	40	20	0	650	650
TOTAL					**60**	**2000**		

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 π –

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 runway-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*

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,

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 forEngineers and Technologists', Vols. I & II (Combined Edition), Orient Longman Pvt. Ltd., 2006.*
6. *LALA, PUSHP 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', 1st 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 ofenergy, Energy flow diagram to the earth, Origin of fossil fuels, Time scale of fossil fuels, Roleof 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.

UNIT – IV

[12 LECTURES]

Indian Energy Scene: Commercial and non-commercial forms of energy, energy consumption pattern and its variationas 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 andrenewable energy sources, Socio-economic impacts, Rural development, Poverty alleviation,Employment; Security of supply and use, Environmental and ethical concerns, Economicalaspects 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)*

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 – Equi-potential 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.

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-Kamakshaiah, 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*

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 SolankiPHI (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 SolankiPHI (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-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.

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*

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

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*

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

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)*

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.

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.*

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.

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.*

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.

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.*

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 analaysis.

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.

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.

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 there 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.

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).*

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 there 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 o 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

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.*

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 there 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 consumable 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 activity, 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

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.

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:
   Revenue = (Selling price)(Quantity)
   Cost= $10 per unit + fixed Cost
   Profit = Revenue - Cost

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.

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, η in thermosyphonic mode of flow with fixed input parameters.
6. Evaluate U_L, F_R, η in thermosyphonic mode of flow with different wind speeds.
7. Evaluate U_L, F_R, η in thermosyphonic mode of flow with different intensity.
8. Evaluate U_L, F_R, η 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

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 21st century.
2. To develop critical thinking ability using scientific methods through the study of the milestone innovations of the 20th 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 20th 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 20th 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;

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/)*
4. *Manorama Yearbook 2015 Malayala Manorama Press ,Kottayam*
5. *Mathrubhumin Yearbook Plus 2016*

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) (Diversion 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.*

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.

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*

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.

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.*

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 o ensure periodical cleaning of solar module array , periodically ensure tightness of cable connections o 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 warrantees 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

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 Exiting 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.*

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 there characteristics used in water pumping.
3. Estimation of cost, installation and commission 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 o 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

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.*

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*

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 η) in thermosyphonic mode of flow at different radiation level.
10. Evaluation of different parameters (U_L, F_R and η) in thermosyphonic mode of flow with different wind speed.
11. Evaluation of different parameters (U_L, F_R and η) 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.

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.

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.*

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.*

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.*

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.*

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" , 16th edition, Danpat Rai Publications, 2010*
2. *Callister W.D.., Materials Science and Engineering 6th edition, Wiley India, 2009*
3. *Sheckel ford J., F. Muralidham M.K., "Introduction to Materials Science for Engineers", 6th edition, Pearson, 2007.*
4. *RaghavanV.," Materials Science and Engineering", Prentice-Hall India, 2007.*

5. *Askeland D.R., "Science and Engineering of Materials", 4th 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.*

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).

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.

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.*

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 were 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)*

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.*

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 Arbar Science, 1983.*
9. *R.W. Jones, J.D. Balcomb, C.E. Kosiewiez, 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, 1stedition, 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 photo-catalytic 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.*

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*

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.

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.EI- 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.*

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.

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.

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.