BOARD OF STUDIES IN GEOLOGY

COURSE CURICULUM
FOR
M. Sc. GEOLOGY (Four Semesters Course)
including
CHOICE BASED CREDIT SYSTEM (CBCS)

Academic Session 2019 – 20, 2020 – 21 & 2021-22

There shall be four semesters in two academic years. Each semester (except the IVth Sem.) consists of Four Theory courses carrying 100 marks each and two Lab courses carrying 100 marks each. Each semester carries 20 credits. Thus, a student will have to clear all 80 credits. The practical examination would be of 3 to 4 hours duration. In each practical 20 % marks shall be allotted for Sessional work, 10% marks are allotted for viva-voce.

Fieldwork: Fieldwork is an essential component of the course, and carries 2 Credits. Every student will have to do 2 to 3 weeks of fieldwork (in continuation or in breaks) during the first academic year. He will be required to submit a field report for evaluation under FIELD WORK of second semester examination.

In IVth Semester, there will be Three Major/Core Theory Papers and One Major/core ELECTIVE Paper, along with respective practical. Besides this, a student will have to clear two Papers of 3 credit each out of the Minor ELECTIVE course from other Subjects/Disciplines as per his/her choice.

A student has to submit his choice of Core ELECTIVE Papers at the beginning of III Semester. If a candidate chooses for The Project Oriented Dissertation in lieu of Core ELECTIVE Paper, he/she shall be allotted a topic for the Project work. He/She will have to complete his fieldwork related to Project before the commencement of Fourth Semester, while Laboratory work can be completed along with regular course of study during Fourth Semester. M. Sc. Dissertation thesis must be submitted within 30 days after the completion of IVth Semester theory examination.

Academic Session 2019 – 20 & 2020 – 21

SCHEME OF EXAMINATION

SEMESTER – I CORE COURSES

Course No	Title of Paper	Max Marks			Credits
		Theory	Internal Assmt.	Total	
I	Structural Geology	80	20	100	4
II	Mineralogy	80	20	100	4
III	Geochemistry	80	20	100	4
IV	Crystallography & crystal optics	80	20	100	4
Lab Course I	Structural Geology & Survey	100	-	100	2
Lab Course II	Crystallography, Crystal Optics, Mineralogy & Geochemistry	100	-	100	2
	Total	520	80	600	20

SEMESTER – II CORE COURSES

Course No	Title of Paper	Max Marks			Credits
		Theory	Internal Assmt.	Total	
I	Igneous Petrology	80	20	100	4
II	Metamorphic Petrology	80	20	100	4
III	Sedimentalogy & Crustal Evolution	80	20	100	4
IV	Stratigraphic principles and Indian Geology	80	20	100	4
Lab Course -I	Petrology and Stratigraphy	150	-	150	2
Lab Course -II	Fieldwork	50	-	50	2
	Total	520	80	600	20

SEMESTER – III CORE COURSES

Course No	Title of Paper	Max Marks			Credits
		Theory	Internal Assmt.	Total	
I	Paleontology	80	20	100	4
II	Ore & Fuel Geology	80	20	100	4
III	Geomorphology and Remote Sensing	80	20	100	4
IV	Mineral Exploration	80	20	100	4
Lab Course -I	Ore Geology and Mineral Exploration	100	-	100	3
Lab Course -II	Paleontology, Geomorphology and Remote sensing	100	-	100	3
	Total	520	80	600	22

SEMESTER – IV CORE COURSES

Course No	Title of Paper	Max Marks			Credits
		Theory	Internal Assmt.	Total	
I	Mining and Engineering Geology	80	20	100	4
II	Environmental Geology	80	20	100	4
III	Hydrogeology	80	20	100	4
Lab Course –I	Hydrogeology, Engineering Geology and Mining geology	150	-	150	2
	Total	390	60	450	14

CORE ELECTIVE COURSES (ANY ONE)

Course No	Title of Paper	Max Marks			Credits
		Theory	Internal Assmt.	Total	
ME I	Advanced Hydrogeology	80	20	100	4
Lab course ME- I	Advance hydrogeology	50		50	2

ME II	Project Oriented Dissertation	100		100	4
	Script Evaluation and Viva Voce on Project Dissertation	50		50	2
	Total	130		150	6
		Max Marks			**Credits**
		Theory	Internal Assmt.	Total	
	Grand Total Minor elective courses	2080	320	2400	80 06

MINOR ELECTIVE COURSES

		Max Marks	**Credits**
		Total	
GMnE-1	Fundamentals of Geology	100	3
GMnE-2	Disaster Management	100	3

SEMESTER - I

COURSE: I - STRUCTURAL GEOLOGY

UNIT – I

1.1 Rock deformation: Theory of stress & strain, their relationship; Factors controlling rock deformation

1.2 Properties of elastic, plastic and brittle materials; Progressive deformation.

1.3 Strain analysis: types of strain; strain ellipse; strain ellipsoid; Geological application of strain theory. Rheology.

1.4 Stress analysis: compressive and shear stress; biaxial and triaxial stress. Mohr's Circle and envelope.

UNIT – II

2.1 Fold: Definition, Geometrical and Genetic Classification of Fold. Fleutys Classification, Ramsay Classification and Dip Isogon Classification.

2.2 Mechanism of Fold formation and types of fold

2.3 Superimposed fold; Outcrop pattern of superimposed structure comprising of two fold system.

2.4 Joints, and its types; their analysis and relation with major structures

UNIT – III

3.1 Fault: Types and mechanism of faulting.

3.2 Principal stress orientation for the main fault types; Relationship between stress and strain ellipsoid.

3.3 Analyses of brittle-ductile and ductile shear zones

3.4 Petrofabric Analysis: Field and laboratory techniques. Preparation of petrofabric diagrams and their interpretation.

UNIT – IV

4.1 Cleavage & Schistosity: definition and types.

4.2 Mechanism of formation of Cleavage & Schistosity; its relationship with major deformation structures

4.3 Lineation: definition and its types; their mode of development and relation to major structures.

4.4 Plutons: Definition & description; its role in progressive deformation.

UNIT – V

5.1 Tectonites: definition and its types

5.2 Stereographic Projection: Principles and application

5.3 Tectonics and structural characteristics of Plate Boundaries; associated structures in extensional, compressional and strike-slip terrains.

5.4 Geodynamic evolution of the Himalayas

Books Recommended:

Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Development. Pergamon Press.

Hobbs, B.E., Means, W.D. and Williams, P.F. (1976): An outline of Structural Geology, John Wiley and Sons, New York.

Ramsay, J.G. (1967): Folding and fracturing of rocks, McGraw Hill.

Ramsay, J.G. and Huber, M.I. (1983): Techniques of Modern Structural Geology, Vol. I Strain Analysis, Academic Press.
Ramsay, J.G. and Huber, M.I. (1987): Techniques of Modern Structural Geology, Vol. II, Folds and Fractures, Academic Press.
Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology, Vol. III (Application of continuum mechanics), Academic Press.
Turner, F.J. and Weiss, L.E. (1963): Structural analysis of Metamorphic Tectonites, McGraw Hill.
Windley B. (1973): The Evolving continents, John Wiley and Sons, New York.

SEMESTER - I **COURSE: II - MINERALOGY**

UNIT- I

1.1 Composition of minerals and Mineraloids.
1.2 Physical Properties of Minerals depending on Crystal Growth, Crystal Structure, Chemical Composition and Interaction with light.
1.3 Electrical Magnetic, Luminescence, Thermal and Radioactive Properties of Mineral.
1.4 Structure of Silicates.

UNIT- II

2.1 Ionic Radius, Coordination Principles, Close Packing, Pauling's Rules.
2.2 Unit Cell, Bonding Forces in crystals Ionic Bond, Covalent Bond, Van Der Waal's Bond, Metallic Bond.
2.3 Solid solution - Substitution, Interstitial and Omission solid solution. Ex-solution.
2.4 Polymorphism, polytypism, pseudomorphism.

UNIT – III

Classification of Minerals. Systematic Mineralogy of common rock forming silicate groups.

3.1 Classification of Minerals
3.2 Nesosilicates – a) Olivine Group b) Garnet Group c) Al2SiO5 Group d) Zircon,
3.3 a) Topaz, b) Staurolite, c) Sphene.
3.4 Sorosilicates - Epidote

UNIT- IV

Systematic Mineralogy of common rock forming silicate groups

4.1 Cyclosilicates- a) Cordierite b) Tourmaline c) Beryl
4.2 Inosilicates - a) Pyroxene Group
4.3 Inosilicates – a) Amphibole Group
4.4 Phyllosilicates- a) Serpentine Group b) Mica Group c) Chlorite Group d) Clay Mineral Group – Kaolin and Talc,

Unit – V

Systematic Mineralogy of common rock forming silicate, carbonate and phosphate groups

5.1 Tectosilicates- a) SiO_2 Group b) Zeolite Group
5.2 Tectosilicates – a) Feldspar Group b) Feldspathoid Group
5.3 Carbonates and Phosphates
5.4 Gem and Semi precious minerals.

Books Recommended:

Berry, L.G., Mason, B. and Dietrich, R.V. (1982): Mineralogy, CBS Publ.
Dana, E.S. and Ford, W.E.(2002): A textbook of Mineralogy (Reprint).
Kerr, P.F. (1977): Optical Mineralogy, McGraw Hill.
Moorhouse, W.W. (1951): Optical Mineralogy, Harper and row Publ.
Nesse, D.W. (1986): Optical Mineralogy, McGraw Hill.
Perkins, D. (1998): Mineralogy, Prentice Hall.
Winchell, E.N. (1951): Elements of Optical Mineralogy, Wiley Eastern.

SEMESTER - I **COURSE: III - GEOCHEMISTRY**

UNIT – I

1.1 Introduction to Geochemistry. Cosmic Abundance of the Elements and Nucleosynthesis. Geochemical classification of elements. Formation of Solar System and Planets.

1.2 Composition and Classification of Meteorites, Chondrules, Chondrites and Achondrites. Geology and Chemistry of Moon.

1.3 Trace, Volatile, Semi volatile, Alkali and Alkaline earth elements its behaviour in Fractional Crystallization and Partial melting.

1.4 REE and Y, HFSE elements, Transition & Noble elements-its importance and concentrations in various igneous rocks and its behaviour in various magmatic processes.

UNIT – II

2.1 Partition coefficient, Factors governing partition co-efficient.

2.2 Compatible and incompatible elements, behaviour of these elements in Fractional Crystallization and partial melting.

2.3 Fundamental Laws of Thermodynamics. Free energy. Phase equilibrium and Gibb's Phase Rule.

2.4 Thermodynamics of magmatic Crystallization.

UNIT – III

3.1 Geochemistry of island arcs.

3.2 Geochemistry of Crust.

3.3 Composition of Mantle, mineralogy of lower mantle.

3.4 Phase transition in the Mantle, mineral-phase transition in lower mantle.

UNIT – IV

4.1 Stable isotope geochemistry. Oxygen isotope studies. Isotope fractionation, application, use of oxygen isotope together with radiogenic isotope in correlation diagrams.

4.2 Carbon isotope. Carbon isotope studies in association with Oxygen isotope for Carbonate rocks.

4.3 Radiogenic isotopes.Decay scheme, Laws of decay, half-life period. Decay scheme of K-Ar, Sm-Nd and Rb-Sr. Radiogenic isotopes in petrogenesis

4.4 Isotopic reservoirs, Depleted mantle (DM), HIMU Mantle, Enriched Mantle, PREMA, Bulk Silicate Earth (BSE), Continental crustal source.

UNIT - V

5.1 Aquatic Chemistry- Acid Base reactions, Dissolution and Precipitation of $CaCO_3$. Solubility of Mg, SiO_2 and $Al(OH)_3$

5.2 Geochemical properties of clays - Kaolinite, Pyrophyllite and Chlorite Groups. Ion exchange properties of clays

5.3 Redox in Natural Waters. Eutrophication. Factors controlling Weathering. Soil profile. Chemical and
biogeochemical cycling in the soil

5.4 Composition of Rivers. Composition of Seawater- Temperature variation.Density structure and deep circulation, Distribution of CO_2 in Ocean. Carbonate dissolution and precipitation. Sources and sinks of Dissolved matter in seawater.

Books Recommended:

Drever, J. I., 1988. *The Geochemistry of Natural Waters,* Prentice Hall, Englewood Cliffs, 437 p.

Garrels, R. M. and C. L. Christ. 1965. *Solutions, Minerals and Equilibria*. New York: Harper and Row.

Burns, R. G. 1970. *Mineralogical Applications of Crystal Field Theory*. Cambridge: Cambr Univ. Press.

Henderson, P. 1986. *Inorganic geochemistry*. Oxford: Pergamon Press.

Brownlow, A. H. 1996. *Geochemistry*. New York: Prentice Hall.

Krauskopf, K. B. and D. K. Bird. 1995. *Introduction to Geochemistry*. New York: McGraw-Hill.

Bowen, R. 1988. *Isotopes in the Earth Sciences*, Barking (Essex): Elsevier Applied Science Publishers.

Condie, K. C. 1989. *Plate Tectonics and Crustal Evolution*. Oxford: Pergamon.

Rollinson Hugh R. *Using Geochemical Data: Evaluation, Presentation, Interpretation*

Faure, G., 1986. *Principles of Isotope Geology,* 2nd ed., Wiley & Sons, New York, 589p.

Hoefs Jochen: *Stable Isotope Geochemistry*

Dickin Alan P*.: Radiogenic Isotope Geology*

White, W. M. *Geochemistry*

SEMESTER – I **COURSE: IV - CRYSTALLOGRAPHY & CRYSTAL OPTICS**

UNIT – I

1.1 Crystal growth. Development of ideas of internal structure of crystals.
1.2 Space lattices and point systems. X-ray analysis of crystal structure, SEM, TEM.
1.3 Morphology of crystals. Fundamental Laws of Crystal Zones and Zonal Symbols.
1.4 Symmetry elements, operations. Classification of Crystals in 32 Classes.

UNIT – II

2.1 Symmetry and forms of crystals of isometric, tetragonal and hexagonal systems.
2.2 Symmetry and forms of crystals of orthorhombic, monoclinic and triclinic systems.
2.3 Goniometry of Crystals. Crystal Projections – Spherical, Gnomonic and Stereographic.
2.4 Crystal Aggregates, Twinning, Irregularities & Imperfections in Crystals.

UNIT – III

3.1 Principles of transmission and reflection of light from crystals. Classification of minerals according to interaction of light, Interference colour.
3.2 Refraction and Refractometry. Methods of determination of R.I.
3.3 Birefringence in Crystals. Significance and use of plates, wedge and Bereck Compensator.
3.4 Pleochroism in Crystals.

UNIT-IV

4.1 Classification of Crystals into isotropic, Uniaxial and Biaxial minerals.
4.2 Isotropic, uniaxial and biaxial indicatrix.
4.3 Optical characters of Isotropic and uniaxial minerals.
4.4 Optical characters of biaxial minerals.

UNIT - V

5.1 Optical Orientation – Extinction angle, Universal stage. Construction & Use.
5.2 Dispersion in mineral optic axial angle.
5.3 Optical anomalies.
5.4 Systematic determination of optical properties of minerals.

Books Recommended:

Phillips, F.C (1971): Introduction to Crystallography,Longman Group Publ.
Dana, E.S. and Ford, W.E. (2002): A textbook of Mineralogy (Reprint).

PRACTICALS

LAB COURSE – I

A] Structural Geology

1. Concept of line and plane, attitude of plane and line. Bedding plane, dip and strike, and their measurement

2. Criteria for determination of top and bottom of strata in structurally deformed terrain and its study in hand specimen.
3. Preparation and interpretation of geological maps for simple structure contour maps, as well as, for fold, fault and unconformity
4. Stereographic projection – problems in angular relationship true dip, apparent dip plunge and rake of the intersection of planes.
5. Three point problems: Geometric solutions for three-point problems.

B] Survey

1. Field techniques of geological mapping using:
2. a) Chain tape; Plane table and Prismatic compass
3. b) Global Positioning System.

LAB COURSE – II

A] Mineralogy and Geochemistry

1. Megascopic study of common rock forming minerals.
2. Microscopic study of common rock forming minerals.
3. Principles and methods of geochemical analysis. Calculation of mineral formulae.
4. Determination of total hardness in water.
5. Spot test for qualitative analysis.

B] Crystallography and Crystal Optics

1. Morphological study of crystal models and twins.
2. Stereographic projection of crystals.
3. Optical determination of
   1. Refractive Index.
   2. Order of Interference colour and birefringence.
   3. Interference figure and optic sign.
   4. Scheme of pleochroism.
   5. An content (Michel Levy's method)
   6. 2V.

SEMESTER – II

COURSE: I – IGNEOUS PETROLOGY

UNIT- I

1.1 Factors affecting magma and its evolution. Composition of primary magma; mantle mineralogy.
1.2 Partial melting of mantle – different models. Trace element behavior during partial melting.
1.3 Magmatic differentiation processes.
1.4 Behavior of major and trace elements during fractional crystallization.

UNIT – II

2.1 Concurrent assimilation and fractional crystallization. Magma mixing.
2.2 Various criterion for classification of Igneous rocks
2.3 Petrographic Province. Different variation diagrams and their applications.
2.4 Crystallization of basaltic magmas. Generation of magma with reference to plate tectonics.

UNIT - III

Study the petrogenetic significance of following silicate systems:
3.1 Albite-Anorthite
3.2 Forsterite – Silica
3.3 Diopside-Albite-Anorthite
3.4 Dioside-Forsterite- Silica Nepheline-kalsilite-silica

UNIT – IV

Petrogenetic study of the following rock types and their distribution in India:
4.1 Basalt and Ophiolite
4.2 Peridotite and other Ultramafic rocks
4.3 Granite, Anorthosite
4.4 Komatite, Kimberlite and Lamproite

UNIT- V

5.1 Petrogenetic study of the Carbonatite, Lamprophyre, and their distribution in India.
5.2 Mid-ocean ridge volcanism and oceanic intra-plate volcanism.
5.3 Magmatism associated with subduction related igneous activity- continental and island arcs.
5.4 Magmatism in Large Igneous Plutons and continental alkaline magmatism.

Books recommended:

Bose, M.K. (1997): Igneous Petrology, World Press, Kolkata.
Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science.
Cox, K.G., Bell, J.D.and Pankhurst, R.J. (1993):The Interpretation of Igneous Rocks, Champman and Hall, London.
Faure, G. (2001): Origin of Igneous Rocks, Springer.
Hall, A. (1997): Igneous Petrology, Longman.

LeMaitre R.W. (2002): Igneous Rocks: A Classification and Glossary of Terms, Cambr University Press.
McBirney (1994): Igneous Petrology, CBS Publ., Delhi.
Phillpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology, Prentice Hall of India.
Sood, M.K. (1982): Modern Igneous Petrology, Wiley-Interscience Publ., New York.
Srivastava, Rajesh K. and Chandra, R., (1995): Magmatism in Relation to Diverse Tectonic Settings, A.A. Balkema, Rotterdam.
Wilson, M. (1993): Igneous Petrogenesis, Chapman and Hall, London.
Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology, Prentice Hall, New Jersey.

SEMESTER – II **COURSE: II - METAMORPHIC PETROLOGY**

UNIT – I

1.1 Definition of metamorphism, significance of metamorphic rocks.
1.2 Agents and kinds of metamorphism.
1.3 Phase rule and its application in metamorphism.
1.4 Structure and texture of metamorphic rocks and their significance. Classification of metamorphic rocks.

UNIT – II

2.1 Fabric of metamorphic rocks.
2.2 Evolution of the concept of depth zones. Systematic study of Barrovian and Abukuma zones of metamorphism.
2.3 Grade of metamorphism, Isograde & reaction Isograde and construction of petrogenetic grids.
2.4 Study of ACF, AKF and AFM diagrams.

UNIT- III

3.1 Concept of Facies and Facies series.
3.2 Polymetamorphism and Paired metamorphic belts.
3.3 Metamorphic differentiation.
3.4 Retrograde Metamorphism and Crystalloblastic series.

UNIT - IV

4.1 General Characters of thermal and regional metamorphism of Calcareous, Pelitic and Basic igneous rocks. Migmatites.
4.2 Tectonics and Metamorphism
4.3 Metasomatism-Principles and types of metasomatism.
4.4 Anataxis, Palingenesis.

UNIT-V

5.1 Kinetics of metamorphic mineral reaction. Pressure – Temperature – time paths.
5.2 Ultra-high temperature metamorphism
5.3 Ultra-high pressure metamorphism.
5.4 Petrogenetic significance of following rocks with special reference to Indian occurrences:
Charnockite, Amphibolite, Khondalite, Gondite, Eclogi**te.**

Books Recommended:

Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., NewYork.

Bucher, K. and Martin, F. (2002): Petrogenesis of Metamorphic Rocks (7th Rev. Ed.), Springer–Verlag,.

Kerr, P.F. (1959): Optical Mineralogy, McGraw Hill Book Company Inc., New York.

Philpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology, Prentice Hall.

Powell, R. (1978): Equilibrium thermodynamics in Petrology: An Introduction, Harper and Row Publ., London.
Rastogy, R.P. and Mishra, R.R. (1993): An Introduction to Chemical Thermodynamics, Vikash Publishing House.
Spear, F. S. (1993): Mineralogical Phase Equilibria and pressure – temperature – time Paths, Mineralogical Society of America.
Spry, A. (1976): Metamorphic Textures, Pergamon Press.
Winter, J.D. (2001): An introduction to Igneous and Metamorphic Petrology, Prentice Hall.
Wood, B.J. and Fraser, D.G. (1976): Elementary Thermodynamics for Geologists, Oxford University Press, London.
Yardley, B.W.D., Mackenzie, W.S. and Guilford, C. (1995): Atlas of Metamorphic Rocks and their textures, Longman Scientific and Technical, England.
Yardlley, B.W.D. (1989): An introduction to Metamorphic Petrology, Longman Scientific and Technical, New York.

SEMESTER- II

SEMESTER- II **COURSE: III - SEDIMENTOLOGY AND CRUSTAL EVOLUTION**

UNIT- I

1.1 Earth surface system – liberation and flux of sediments.
1.2 Processes of transport and generation of sedimentary structures. Flow regimes and related bed forms
1.3 Stromatolites and their significance.
1.4 Textural analysis of sediments, Graphical representation, statistical treatment and geological significance.

UNIT – II

2.1 Classification of sandstone and carbonate rocks. Dolomite and dolomitization.
2.2 Volcaniclastics. Sedimentary environments and facies.
2.3 Continental: alluvial-fluvial facies, Lacustrine, Desert – Aeolian and glacial sedimentary environments.
2.4 Shallow coastal clastics and shallow water carbonates.

UNIT – III

3.1 Evaporites. Deep-sea basins.
3.2 Paleocurrents and basin analysis.
3.3 Clastic Petrofacies. Plaeoclimates and paleoenvironment analysis.
3.4 Diagenesis of sandstone and carbonate rocks – changes in mineralogy, fabric, and chemistry.

UNIT- IV

4.1 Petrogenesis of arkoses, greywacke and quartz arenites.
4.2 Evolution of lithosphere, hydrosphere, atmosphere and biosphere.
4.3 Application of Trace, REE and stable isotopes geochemistry to sedimentalogical problems.
4.4 Surface features of earth – island arcs, mid-oceanic ridges, Young mountain belts and their distribution. Evolution of continental and oceanic crust.

UNIT - V

5.1 Lithological, geochemical, stratigraphic characteristics of granite-greenstone belts
5.2 Evolution of Proterozoic sedimentary basins of India.
5.3 Anatomy of Orogenic belts and formation of mountain roots
5.4 Life in Pre Cambrians, PreCambrian Cambrian boundary with special reference to India

Books Recommended:

Blatt, H., Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks, Prentice-Hall Inc.
Collins, J.D., and Thompson, D.B. (1982): Sedimentary Structures, George Allen and Unwin, London.
Lindholm, R.C. (1987) A Practical Approach to Sedimentology, Allen and Unwin, London.
Miall, A.D. (2000): Principles of Basin Analysis, Springer-Verlag.
Pettijohn;, F.J. (1975): Sedimentary Rocks (3rd Ed.), Harper and Row Publ., New Delhi.
Reading, H.G. (1997): Sedimentary Environments and facies, Blackwell Scientific Publication.
Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments, Springer-Verlag.
Selley, R. C. (2000) Applied Sedimentology, Academic Press.
Tucker, M.E. (1981): Sedimentary Petrology: An Introduction, Wiley and Sons, New York.
Tucker, M.E. (1990): Carbonate Sedimentolgy, Blackwell Scientific Publication.
Allen P. A. and J.R.L. Allen (2005): Basin Analysis: Principles and Application, Blackwell Publ.
Perry, C.T. and Taylor, K.G. (2006): Envoronmental Sedimentology, Blackwell Publ., U.K.
Bird, J.M. (1980): Plate Tectonics, American Geophysical Union, Washington D.C.
Briggs, J.C. (1987): Biogeography and Plate Tectonics, Elsevier.
Lieberman, B. L.(2000): Paleobiogeography: using fossils to study Global Change, Plate Tectonics and Evolution, Plenum Publ., New York.
Jacquelyne Kious, J. and Tilling, R.I. (2007): This Dynamic Earth: The story of Plate Tectonics, USGS Information Services.
Gass I.G. (1982): Understanding the Earth. Artemis Press (Pvt) Ltd.U.K.
Windley B. (1973): The Evolving continents, John Wiley and Sons, New York.

SEMESTER – II **COURSE: IV - STRATIGRAPHIC PRINCIPLES AND INDIAN GEOLOGY**

UNIT – I

1.1 Principles of stratigraphic scales and its divisions, dual classification.
1.2 Stratigraphic units – lihtostratigraphic, biostratigraphic and chronostratigraphic.
1.3 Rules of stratigraphic nomenclature.
1.4 Stratigraphic correlation.

UNIT – II

2.1 Concept of sequence stratigraphy.
2.2 Chief divisions of Indian sub continent and their physiographic characters.
2.3 Archaean Era. Distribution and classification in Peninsula (Mysore, Bihar, M. P. and Rajasthan) and extrapeninsular regions. Their correlation and economic importance.
2.4 Dharwar Supergroup (Classification, Distribution, Economic importance)

UNIT – III

3.1 Cuddaph Supergroup its distribution, classification & equivalent in extra peninsula.
3.2 Vindhyan Supergroup – its distribution classification age economic importance and correlation.
3.3 Chhattisgarh Group, Indravati Group and Khairagarh Group, their classification, age correlation and economic importance.
3.4 Palaeozic formations of extra peninsular regions with special reference to their classification distribution and correlation.

UNIT – IV

4.1 Distribution, geological succession, classification and climate of Gondwana Supergroup.
Age and correlation of Gondwana formations.
4.2 Jurassic system of rocks – in extrapeninsular region.
4.3 Distribution, Classification & correlation of cretaceous formations of Peninsula and extra peninsulas regions of India.
4.4 Distribution, structural features and age of the Deccan Traps. Inter trappeans and infra trappeans of India

UNIT – V

5.1 Problems of Permo-triaassic and Cretaceous – Palaeocene boundaries.
5.2 Distribution, succession, correlation and life of Siwalik formations.
5.3 Distribution, lithology, correlation & life of the Cenozoics of Assam & Western India and Pleistocence (Quaternary) deposits, Karewa Beds, Indogangetic Alluvium.
5.4 Quaternary climate, glacial and interglacial cycle, Eustatic changes

Books Recommended:

Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
Danbar, C.O. and Rodgers, J. (1957): Principles of Stratigraphy, John Viley and Sons.
Doyle, P. and Bennett. M.R. (1996): Unlocking the Stratigraphic Record, John Viley and Sons.
Krishnan,M.S. (1982): Geology of India and Burma, C.B.S. Publ. and Distributors, Delhi.
Naqvi, S.M. and Rogers, J.J.W. (1987): Precambrian Geology of India, Oxford University Press.
Pascoe, E.H. (1968): A Manual of the Geology of India and Burma (Vols.I-IV), Govt. of India Press, Delhi.
Pomerol, C. (1982): The Cenozoic Era? Tertiary and Quaternary, Ellis Harwood Ltd., Halsted Press.

Schoch, Robert, M. (1989): Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.
Krumbein and Sloss (1963): Stratigraphy and sedimentation II Ed.Freeman & Co.

PRACTICAL

LAB COURSE – I A: IGNEOUS & METAMORPHIC PETROLOGY

1. Megascopic description and identification of igneous and metamorphic rocks.
2. Study of textures and structures of Igneous and metamorphic rocks.
3. Microscopic identification of Igneous and metamorphic rocks.
4. C.I.P.W. Norm calculations and classification of igneous rocks.
5. Constructions of variation diagrams of igneous suits of rocks.
6. Construction of A.C.F., A.K.F. and A.F.M. diagrams.
7. Plotting the Geographical distribution of Igneous and Metamorphic rocks types in and outline map of India.
8. Use of software for norm calculation and geochemical modeling

LAB COURSE – I B: SEDIMENTARY PETROLOGY AND STRATIGRAPHY

1. Megascopic description and identification of sedimentary rocks.
2. Study of sedimentary structures in hand specimen.
3. Microscopic study of sedimentary rocks.
4. Graphic representation of sedimentary data and interpretation.
5. Heavy mineral studies of sediments.
6. Distribution of Important geological formations on outline map of India.
7. Construction of fence diagrams
8. Correlation diagrams. Recognition of transgressive-regressive cycles based on vertical columns.

LAB COURSE - II: GEOLOGICAL FIELD WORK

1. Geological mapping in type areas of India to study structural relations and stratigraphic formations in sedimentary, igneous and metamorphic terrains.
2. Collection and study of primary and secondary structures of rock bodies and their interpretation.
3. Sampling of rocks, minerals and fossils in the field from study areas.
4. Preparation of geological maps and sections from the geological data obtained in the field.
5. Preparation of geological report based on field studies.
6. Viva-Voce on fieldwork and geological report.

SEMESTER - III

COURSE: I - PALAEONTOLOGY

UNIT – I

1.1 Definition of fossil and modes of fossilization their application in age determination, paleoclimatology, palaeogeography and evolution.
1.2 Modes and theories of organic evolution, concept of bathymetric distribution of animals, migration and extinction of species.
1.3 Outline classification of organisms.
1.4 Study of morphology, classification, evolutionary trends and geologic and geographic distribution of Brachiopod.

UNIT – II

Study of morphology, Classification, Evolutionary geologic history of the following

2.1 Pelecypoda (Lamellibranches)
2.2 Gastropoda.
2.3 Cephalopoda
2.4 Trilobites.

UNIT – III

Study of morphology, Classification, Evolutionary geologic history of the following

3.1 Echinoids. Graptolites and Rugose Corals.
3.2 An elementary idea about the origin of major groups of vertebrates.
3.3 Study of evolutionary history of Horse and Elephant Man.
3.4 Study of evolutionary history of Man.

UNIT – IV

4.1 General study of Siwalik mammalian fauna.
4.2 Plant life through geologic ages.
4.3 Study of fossil flora of Gondwana Group and Tertiary Formations of India.
4.4 Definition and scope of micropaleontology.

UNIT - V

5.1 Techniques in micropaleontology.
5.2 Application of microfossils in stratigraphic correlation, age determination and palaeoenvironmental interpretations.
5.3 Study of morphology of foraminifers.
5.4 Classification, evolution and geological distribution of foraminifers.

Books Recommended:

Boardman, R.S., Cheethan, A.M. and Rowell, A.J. (1988): Fossil Invertebrates, Blackwell.

Clarksons, E.N.K. (1998): Invertebrate Paleontology and Evolution, Allen and Unwin, London.

Dobzhansky, Ayala, Stebbins and Valentine (1977): Evolution, Freeman.

Horowitz, A.S. and Potter, E.D. (1971): Introductory Petrography of Fossils, Springer Verlag.

Mayr, E. (1971): Population, Species and Evolution, Harvard.

Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill.

Raup, D.M. and Stanley, S.M. (1985): Principles of Paleontology ,CBS Publ..
Smith, A.B.(1994): Systematics and Fossil Record – Documenting Evolutionary Patterns, Blackwell.
Strean, C.W. and Carroll, R.L. (1989): Paleontology – the record of life, John Wiley.
Bignot, G., Grahm and Trottman (1985): Elements of Micropaleontoogy, London.
Romer, A.S. (1966): Vertebrate Paleontology (3rd Edn.) Chicago University Press

SEMESTER - III **COURSE: II - ORE AND FUEL GEOLOGY**

UNIT – I

1.1 Modern concepts of ore genesis. Spatial and temporal distribution of ore deposits- Global perspective.
1.2 Concept of ore bearing fluids, their origin and migration. Fluid inclusion in ores – limitations and applications.
1.3 Texture, papargensis and zoning in ores.
1.4 Wall rock alteration. Structural, physico-chemical and stratigraphic controls of ore localization.

UNIT – II

2.1 Orthomagmatic ores of mafic-ultramafic association _ Diamonds in Kimberlites, REE in Carbonatite, Ti -V Ores, Chromite and PGE, Ni Ores.
2.2 Cyprus type Cu-Zn Ores.
2.3 Ores of Silicic igneous rocks- Kiruna type Fe-P. Pegmatoids, Greisen and Skarn deposits.
2.4 Porphyry associations – Kuroko type Zn-Pb-Cu, Malanjkhand Type Cu-Mo deposits.

UNIT – III

3.1 Ores of Sedimentary affiliations- Chemical and Clastic sediments. Stratiform and Stratabound ore deposits. (Fe, Mn, non ferrous). Placers and paleoplacers.
3.2 Ores of Metamorphic affiliations. Metamorphism of ores and metamorphogenic ores.
3.3 Ores related to weathered surfaces – Bauxite, Ni and Au laterite.
3.4 Mineralogy, genesis, distribution in India and uses of Cu, Pb, Zn.

UNIT- IV

Mineralogy, genesis, distribution in India and uses of following ore deposits:
4.1 Ion and manganese
4.2 Gold and Silver
4.3 Aluminum and chromium
4.4 National Mineral Policy and mineral concession rules.

UNIT – V

5.1 Definition and origin of Kerogene and coal. Rank, Grade and type of coal. Microscopic constituents of coal.
5.2 Chemical characterization of coal Proximate and Ultimate analysis. Coal bed methane.
5.3 Distribution of Coal in India. Origin, nature and migration of oil and gas. Characteristics of reservoir rocks.
5.4 Oil bearing basins of India. Geology of productive oil fields of India. Mode of Occurrence and association of atomic minerals in nature. Productive geological horizons.

Books Recommended:

Branes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Willey.
Cuilbert, J.M. and Park,Jr. C.F.(1986): The Geology of Ore Deposits, Freidman.
Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
James R. Craig and David J.Vaughan (1994): Ore Microscopy and Petrography.
Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits, Springer-Verlag.
Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
Ramdhor, P. (1969): The Ore Minerals and their Intergowths, Pergamon Press.
Stanton, R.L. (1972): Ore Petrology, McGraw Hill.
Wolf, K.H. (1976-1981): Hand Book of Stratabound and Stratiform Ore Deposits, Elsevier Publ.
Chandra,D.Singh, R.M.Singh,M.P.(2000):Textbook of Coal (Indian context), Tara Book Agency, Varanasi.
Singh, M.P. (1998): Coal and organic Petrology, Hindustan Publishing Corporation, New Delhi.
Texbook of Coal petrology, Gebruder Borntraeger,Stuttgart.
Van Krevelen, D. W. (1993): Coal, Typology-Physics-Chemistry-Constitution), Elsevier Science, Netherlands.
North, F.K. (1985): Petroleum Geology, Allen Unwin.
Selley, R.C. (1998): Elements of Petroleum Geology, Academic Press.
Mineral Concession Rules 1960 (2005), IBM, Nagpur.
Sinha, R.K. and Sharma, N.L. (1976): Mineral economics, Oxford and IBH Publ.

SEMESTER- III

SEMESTER - III **COURSE: III - GEMORPHOLOGY AND REMOTE SENSING**

UNIT – I

1.1 Geomorphic concepts and geomorphic cycle.
1.2 Geomorphic processes – Weathering, soil formation, Mass-Wasting.
1.3 Valley development, cycle of erosion, rejuvenation.
1.4 Drainage patterns and their significance.

UNIT – II

2.1 Fluvial landforms and Glacial landforms
2.2 Karst topography.
2.3 Arid and Eolian landforms
2.4 Coastal and volcanic landforms.

UNIT – III

3.1 Terrain evaluation and concept of morphometric analysis.
3.2 Geomorphological mapping based on genesis of landforms.

3.3 Geomorphic regions of India. Principles of terrain analysis.
3.4 Concept and physical basis of remote sensing. Platforms: Terrestrial, Aerial and Space platforms. Advantages and limitations.

UNIT – IV

4.1 Electromagnetic spectrum and principles of remote sensing.
4.2 Interaction of EMR with atmosphere and earth surface features.
4.3 Remote sensing sensors, data acquisition, visual interpretation and digital processing techniques. Interpretation of topographic and tectonic features
4.4 Aerial photography, photographs and their geometry. Photogrammetry.

UNIT - V

5.1 Satellite remote sensing. Global and Indian space missions. Satellite exploration Programs and their characteristics
5.2 Application of remote sensing in geology.
5.3 Application in Geomorphology.
5.4 Application in groundwater evaluation, terrain evaluation and strategic purposes.

Books recommended:

Drury, S.A. (2001): Image Interpretation in Geology, Allen and Unwin.
Gupta, R.P. (1991): Remote Sensing Geology, Springer-Verlag.
Halis, J.R. (1983): Applied Geomorphology.
Holmes,A.(1992): Holmes Principles of Physical Geology, Edited by P. McL. D. Duff. Chapman and Hall.
Lillesand, T.M. and Kiefer, R.W. (1987): Remote Sensing and Image Interpretation, John Wiley.
Sharma, H.S. (1990): Indian Geomorphology, Concept Publishing Co., New Delhi.
Siegal, B.S. and Gillespie, A.R. (1980): Remote Sensing in Geology, John Wiley.
Thornbury, W.D. (1980): Principles of Geomorphology, Wiley Easton Ltd., New York.

SEMESTER - III **COURSE: IV - MINERAL EXPLORATION**

UNIT- I

1.1 Prospecting & Exploration: Definition and characteristic features. Stages of prospecting, regional and detailed exploration; objectives and practices of these stages.
1.2 Guides to ore search: global, regional and local guides.
1.3 Detailed study of Regional, Physiographic, Stratigraphic, Lithological, Mineralogical and Structural guides.
1.4 Drilling: Type of drills, Diamond drilling, Drilling records and logs, Duty of geologists during drilling.

UNIT- II

2.1 Sampling: General principles, various methods and procedures. Salting. Precautions during Sampling.

2.2 Calculating grade and tonnage of ore: Average grade, volume, specific gravity, tonnage factor, UNFC classification

2.3 Gravity Method of prospecting: Principle and Instrumentation. Gravity field surveys. Gravity corrections: Free-air correction, Bouguer correction, Latitude correction, Terrain correction. Magnetic method of prospecting: Magnetic properties. Magnetic anomaly. Magnetometer. Field survey. Preparation of magnetic anomaly maps. Aeromagnetic surveys.

2.4 Seismic prospecting: Fundamentals of seismic wave propagation. Methods of seismic prospecting: Refraction and reflection seismic methods. Seismic Stratigraphy, Detection of hydrocarbons.

UNIT-III

3.1 Electrical methods of prospecting: Basic principles of resistivity method. Electrical properties of rocks, Flow of current through ground surface, Apparent resistivity, Electrode arrangements, Resistivity survey. Application and interpretation of resistivity data.

3.2 Electromagnetic methods of prospecting: Electromagnetic spectrum and induction, EM frequency and depth of penetration, EM response of conductors, Classification of EM methods and their description: Telluric current method, Magnetotelluric method, CSMT/CSAMT, Tilt angle method, Turam method, VLF method, Transient EM methods, Ground Penetrating Radar.

3.3 Radiometric prospecting and Borehole Logging. Radiometric survey, Application and interpretation of data.

3.4 Borehole logging: Different geophysical logs, Equipment; measurements and interpretation.

UNIT- IV

4.1 Geochemical mobility and association of elements. Forms of primary and surficial dispersion patterns.

4.2 Secondary dispersion processes and anomalies.Factors affecting dispersion patterns.

4.3 Geochemical surveys: Litho-geochemical and Pedo-geochemical surveys.

4.4 Geochemical surveys: Hydro-geochemical, Atmo-geochemical and Bio-geochemical surveys.

UNIT - V

5.1 Case studies of regional exploration for deposits of plutonic associations; vein and replacement types; magmatic sulphides and chromite; pegmatitic depsoits of Sn and rare metals;

5.2 Case studies of regional exploration for deposits of hydrothermal deposits of Au-Ag, base metals, W-Mo, U; skarn deposits; sedimentary and supergene deposits.

5.3 Instrumental analytical techniques.

5.4 Statistical analysis and interpretation of geochemical prospecting data.

Books Recommended:

Dobrin, M.B. and Savit, C.H. Introduction to Geophysical Prospecting, McGraw Hill, New York, 1988

Sheriff, R.E. and Geldart, L.P. Exploration Seismology, Cambridge University Press, Cambridge, 1995.

Telford, W.M., Geldart L.P., and Sheriff, R.E. Applied Geophysics, Cambridge University Press, Cambridge, 1990.

DS Parasanis. Principle of Applied Geophysics (Chapman and Hall, London)
PB Sharma. Environmental and Engineering Geophysics (Cambridge University Press)
TS Ramakrishna. Geophysical Practice in mineral exploration and mapping (Geological Society of India, Memoir 62), 2006.
Peters, W.C. 1987. Exploration and mining geology. 2nd edition. John Wiley & Sons, New York.
Rose, A.W., Hawkes, H.E. & Webb, J.S. 1979. Geochemistry in mineral exploration. Academic Press, London.
Levinson, A.A. 1974. Introduction to exploration geochemistry. Applied Publication Co., CalgaryMarjoribanks, R.W. 1997. Geological Methods in Mineral Exploration and Mining, Chapman & Hall, London.
Kuzvart, M. and Bohmer, M. 1986. Prospecting and Exploration of Mineral Deposits, Elsevier, Amsterdam, 1986.
Edwards, R.P and Atkinson, K. 1986. Ore Deposit Geology and its Influence on Mineral Exploration, Chapman & Hall, New York.
Moon, C.J., Whateley, M.K.G. and Evans, A.M. 2006. Introduction to mineral exploration, 2nd edition. Blackwell Publishing Ltd. Oxford.
Arogyaswami, R.P.N. (1996): Courses in Mining Geology, Oxford and IBH Publ.
Bagchi,T.C.,Sengupta, D.K.,Rao, S.V.L.N. (1979):Elements of Prospecting and Exploration, Kalyani Publ.
Banerjee , P.K. and Ghosh, S. (1997): Elements of Prospecting for Non-fuel Mineral deposits, Allied Publ.
Chaussier, Jean – Bernard and Morer, J. (1987): Mineral Prospecting Manual. North Oxford Academic.
Dhanraju, R. (2005): Radioactive Minerals, Geol. Soc. India, Bangalore.
Rajendran, S. (2007): Mineral Exploration: Recent Strategies.
Sinha, R.K. and Sharma, N.L. (1976): Mineral economics, Oxford and IBH Publ.

PRACTICAL

LAB COURSE: I - ORE GEOLOGY AND MINERAL EXPLORATION

1. Megascopic study of metallic and nonmetallic economic minerals. Description and identification, uses and distribution in India.
2. Description and identification of ore minerals in polished section of ores.
3. Study of ore textures and structure under the microscope.
4. Paragenetic study of ore minerals and construction of Paragenetic diagrams.
5. Location of important metallic and non-metallic mineral compels in a map of India.
6. Calculation of ore reserves and assay values.
7. Study and interpretations of Isopach and Isograde maps.
8. Evaluation of simple mining plans.
9. Interpretation of Geophysical and geochemical anomaly maps.
10. Numerical problems based on Geophysical and geochemical data.

LAB COURSE: II

[A] PALEONTOLOGY

1. Study and identification of important invertebrate, vertebrate and plant fossils. Drawing of neat sketches of fossils.
2. Sketching and labeling of representative fossil specimens.
3 Identification and study of important foraminifers.

[B] GEOMORPHOLOGY AND REMOTE SENSING

1. Identification and interpretation of drainage patterns
2. Drawing of labeled diagrams of landforms
3. Determination of stream order, bifurcation ratio, drainage density, stream frequency, infiltration number.
4. Slope studies of landforms.
5. Study of areal photographs and satellite imageries and identification of landforms.

SEMESTER - IV

COURSE: I – MINING GEOLOGY, ENGINEERING GEOLOGY AND MINERAL DRESSING

UNIT – I

1.1 Definition of mining terms: pitting, trenching, adits, tunnels, and shafts.
1.2 Role of geologist in mining industry.
1.3 Geological structures of ore deposits and choice of mining methods.
1.4 Mine Subsidence and mine support. Rock bursts, Mine Ventilation. Mine Drainage.

UNIT – II

2.1 Geological and geomorphic control on mining methods. Alluvial mining.
2.2 Open pit mining. Methods of opencast mining; its advantages and limitations.
2.3 Underground mining methods – drifting; cross cutting; winzing; stoping; room and pillaring; top –slicing; sub- level caving and block caving.
2.4 Coal mining methods: Long wall, Board and Pillar method.

UNIT - III

3.1 Engineering properties of rocks and soil. Physical characters of building stones. Aggregate.
3.2 Geological considerations for evaluation of Dam and reservoir sites. Dam foundation problems. Dam failure.
3.3 Geotechnical evaluation of tunnel alignment and transportation routes. Methods of tunneling.
3.4 Role of geologist in engineering projects.

UNIT - IV

3.1 General principles and scope of Mineral Dressing.
3.2 Primary and secondary breaking, crushing and grinding, liberation by sizes, reduction.
3.3 Principles and methods of screening.
3.4 Principles and methods of classification, classification as a means of concentration.

UNIT- V

4.1 Concentration methods, hand sorting, washing, jigging, tabling heavy fluid.
4.2 Magnetic and electrostatic methods of separation of minerals.
4.3 Floatation methods- Principles and techniques with examples.
4.4 Application of ore microscopy in mineral dressing.

Books Recommended:

Dobrin, M. B.; Savit, C. H. (1988): Introduction to Geophysical Prospecting, McGraw-Hill.

Keary, P., Brooks, M. and Hill, I. (2002): An introduction to geophysical exploration, (3rd Ed.),

Blackwell.

Krynine, D.H. and Judd, W.R. (1998): Principles of Engineering Geology, CBS Publ..

Rider, M. H. (1986): Whittles Publishing, Caithness. The Geological Interpretation of Well Logs, (Rev. Ed).

Schultz, J.R. and Cleaves, A.B. (1951): Geology in Engineering, John Willey and Sons, New York.

Singh, P. (1994): Engineering and General Geology, S.K. Kataria and Sons, Delhi.

Bell F G Engineering Geology, Second Edition by, 2007. Butterworth-Heinemann, Oxford 5. Sathya Narayanaswami. Engineering Geology. Dhanpat Rai and Co. 1710, Nai Sarak, Delhi- 110006.. 2000

SEMESTER - IV **COURSE: II – ENVRIONMENTAL GEOLOGY**

UNIT- I

1.1 Definition, Scope and Basic concepts of Environmental Geology.
1.2 Environment, Ecology, Ecosystems and habitat.

1.3 Renewable and non-renewable natural resources.
1.4 Role of geology in natural resources management and environmental planning.

UNIT- II

2.1 Landforms as ecosystem units.
2.2 Characteristics of various environmental regimes – fluvial, coastal, marine, Aeolian, desert, and glacial.
2.3 Understanding their causes, types, Mitigation and Management. Geomorphic controls on biodiversity and its conservation.
2.4 Conservation of soil and water resources.

UNIT- III

3.1 Geological hazards: Lands slides, Volcanic activity, Earthquake and Tsunami.
3.2 Understanding their causes, types, Mitigation and Management.
3.3 Draught and desertification, Measures of mitigation.
3.4 Sea level changes. Measures of mitigation.

UNIT - IV

4.1 Geological hazards -River flooding, erosion and sedimentation, coastal erosion, cyclones and tsunamis.
4.2 Human modifications of nature on surface and subsurface by engineering.
4.3 Human modifications of nature on surface and subsurface by mining activities.
4.4 Human settlement and contamination of atmosphere, soil, surface water and groundwater by waste disposal and agro-industries.

UNIT- V

5.1 National Environmental Policy for air and water pollution.
5.2 National Environmental Laws.
5.3 Climate Change and global warming: Causes and Impact (Ozone layer depletion and ozone hole).
5.4 Environment impact assessment report and preparation of environment Management plans.

Books Recommended:

Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press.
Keller, E.A.(1978): Environmental Geology, Bell and Howell, USA.
Nagabhushaniah, H.S. (2001): Goundwater in Hydrosphere, CBS Publ.
Perry, C.T. and Taylor, K.G. (2006): Environmental Sedimentology, Blackwell Publ.
Singh, S. (2001): Geomorphology, Pustakalaya Bhawan, Allahabad.
Todd, D.K. (1995): Groundwater Hydrology, John Wiley and Sons.
Valdiya, K.S.(1987): Environmental Geology – Indian Context, Tata McGraw Hill.
Montgomery, C.W. Environmental Geology, Won. C. Brown, Publishers, Iowa, 1989.
Dorothy Merritts, Andrew de Wet, Kirsten Menking, Environmental Geology W. H. Freeman & Co. and Sumanas, Inc. USA, 1997

SEMESTER - IV **COURSE: III – HYDROGEOLOGY**

UNIT- I

1.1 Scope of hydrogeology and its relation with hydrology, meteorology and their uses in the Hydrogeological investigation.
1.2 Hydrologic cycle. Role of groundwater in the hydrologic cycle.
1.3 Hydrograph, data collection and analysis.
1.4 Water table and piezometric surface. Water table fluctuation. Water table contour maps, interpretation and uses.

UNIT- II

2.1 Water bearing formation - aquifers, aquitard. aquiclude, aquifuse. Aquifer types: perched, unconfined, semi-confined and confined. Isotropic, anisotropic aquifers.
2.2 Porosity, permeability. Ground water movement: Darcy's law and its applications.
2.3 Specific yield and specific retention. Storativity and transmissivity
2.4 Steady and unsteady flow, leaky aquifers. Groundwater flow near aquifer bundaries

UNIT- III

3.1 Bounded aquifers. Image wells.
3.2 Water wells and their types. Construction of wells.
3.3 Well Development and completion.
3.4 Pumping test and Yield of wells.

UNIT-IV

4.1 Geological and Hydrogeological methods of groundwater exploration.
4.2 Geophysical methods – Electrical resistivity method for groundwater exploration
4.3 Application of remote sensing in groundwater exploration.
4.4 Basin wise development of groundwater with special reference to Chhattisgarh region.

UNIT – V

5.1 Groundwater provinces of India.
5.2 Sources of dissolved constituents in groundwater. Groundwater quality standards-drinking, domestic, agriculture and industry. Groundwater pollution.
5.3 Groundwater management. Safe yield, overdraft and spacing of wells.
5.4 Conservation of Groundwater; conjunctive use of water. Artificial recharge.

Books Recommended:

C.F. Tolman (1937): Groundwater, McGraw Hill , New York and London.

D.K. Todd (1995): Groundwater Hydrology, John Wiley and Sons.

F.G. Driscoll (1988): Groundwater and Wells, UOP, Johnson Div.St.Paul. Min. USA.

H.M. Raghunath (1990): Groundwater, Wiley Eastern Ltd.

H.S. Nagabhushaniah (2001): Groundwater in Hydrosphere (Groundwater hydrology), CBS Publ.

K. R. Karanth (1989): Hydrogeology, Tata McGraw Hill Publ.

S.N. Davies and R.J.N. De Wiest (1966): Hydrogeology, John Wiley and Sons, New York

PRACTICAL

LAB COURSE – I **150 Marks**

[A] HYDRGEOLOGY

1. Hydrogeological properties of rocks.
2. Interpretation of water table maps.
3. Computation of pumping test data.
4. Interpretation of Hydrogeochemical data and their plotting in different diagrams.
5. Sieve analysis and screen gravel pack design.
6. Plotting of groundwater provinces on an outline map of India.
7. Computation of Resistivity (VES) data.

[B] ENGINEERING GEOLOGY AND MINING GEOLOGY

1. Interpretation of engineering properties of rocks in hands specimens.
2. Determination of compressive, tensile and sheer strength of rocks.
3. Determination of porosity and absorption of building materials.
4. Mechanical analysis of soils and unconsolidated materials.
5. Preparation of core-logs and their Geotechnical interpretation from bore hole data.
6. Plotting the geographical distribution of important dams, tunnels on the outline of India.
7. Terrain studies from satellite imageries, aerial photographs and Toposheet.
8. Concentration methods- with flow sheets of common types of mineral and ore dressing practicess in India - Gold, copper, Lead-zinc, coal, beach sand, fluorite, iron, manganese, chromite and limestone.

CORE ELECTIVE COURSES

ME- I ADVANCED HYDROGEOLOGY

UNIT- I

1.1 Hydrologic cycle, ground water in hydrologic cycle
1.2 Hydrograph and hydrographic analysis
1.3 Water balance studies
1.4 Springs (including thermal): Origin and movement of water.

UNIT- II

2.1 Geologic structures favouring groundwater movement. Groundwater reservoir properties.
2.2 Forces and laws of groundwater movement.
2.3 Well hydraulics: confined, unconfined, unsteady and radial flow. Water level fluctuation and its causative factors.
2.4 Water well technology: Well types, drilling methods, construction, designing, development and maintenance of wells.

UNIT- III

3.1 Groundwater in arid and semiarid regions.
3.2 Groundwater in coastal and alluvial regions.
3.3 Groundwater in hard rocks and limestone terrain. Environmental impact on groundwater extraction.

3.4 Ground water recharge: artificial and natural. Factors controlling recharge. Conjunctive and consumptive use of groundwater.

UNIT- IV

4.1 Chemical characterization of groundwater in relation to domestic and industrial uses.
4.2 Chemical characterization of groundwater for irrigation purposes.
4.3 Water pollution: remedial measures and treatment
4.4 Problems of arsenic and fluoride in water.

UNIT-V

5.1 Geological and hydrogeological methods of groundwater exploration.
5.2 Geophysical surface resistivity and seismic methods in groundwater exploration. Geophysical water well logging.
5.3 Application of remote sensing and radiogenic isotopes in hydrogeological studies.
5.4 Basin-wise groundwater management.

LAB COURSE: ME-IL

1 Morphometric analysis of Watershed
2 Interpretation of groundwater features on water table maps
3 Computation of storativity and transmissivity of aquifer from pumping test data
4 Interpretation of subsurface layers from resistivity field survey data
5 Chemical quality assessment of groundwater
6 Use of Software for morphometric analysis,

ME-II PROJECT ORIENTED DISSERTATION

SCRIPT EVALUATION	**100**
SEMINAR	**25**
VIVA VOCE	**25**

MINOR ELECTIVE (CBCS)

GMnE-I FUNDAMENTAL OF GEOLOGY

UNIT- I

1.1 Earth in the Solar System
1.2 Age of the earth. Interior of the earth.
1.3 Brief introduction of hydrosphere and atmosphere. Hydrologic Cycle.
1.4 Deformation in rocks. Folds, Faults and Unconformities

UNIT- II

2.1 Earthquakes and Volcanoes.
2.2 Continental Drift
2.3 Fundamentals of Plate Tectonics and Plate boundaries
2.4 Distribution of Oceans and Continents.

UNIT- III

3.1 Definition and classification of minerals.
3.2 Classification of rocks, rock forming minerals.
3.3 Igneous rocks and their types.
3.4 Sedimentary and Metamorphic rocks and their types.

UNIT- IV

4.1 Basics of Geomorphology. Weathering & Erosion.
4.2 Geomorphic features formed due to wind and river.
4.3 Geomorphic features formed due to glaciers and coastal erosion.
4.4 Fossils and their applications

UNIT- V

5.1 Names of the ore minerals for Iron, Manganese & Bauxite and their occurrences in India.
5.2 Names of the ore minerals for Copper, Lead & Zinc and their occurrences in India.
5.3 Fossil Fuels: Coal and Petroleum- mode of occurrence and distribution in India
5.4 Conservation of mineral resources.

Books Recommended:

Mukherjee, P. K. (2005). Text Book of Geology, The World Press Pvt. Ltd.
Roy, A. B. (2010). Fundamentals of Geology, Narosa Pub. House Pvt. Ltd.
Rogers and Adams (1966), Fundamentals of Geology, Harper & Row

GMnE- 2 DISASTER MANAGEMENT

UNIT- I

1.1 Understanding the Concepts and definitions of Disaster

1.2 Definitions of Hazard, Vulnerability, Risk,
1.3 Disaster and Development, and Concept of Disaster Management
1.4 Classification of Disasters

UNIT- II

2.1 Geological Disasters (earthquakes, landslides, tsunami, mining)
2.2 Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves)
2.3 Biological Disasters (epidemics, pest attacks, forest fire)
2.4 Man-made Disasters, Industrial Disasters

UNIT – III

3.1 Disaster Management Cycle
3.2 Hazard Risk Concept and Elements.
3.3 Risk Analysis and Risk Assessment.
3.4 Resource Analyses and Mobilisation.

UNIT- IV

4.1 Disaster Profile of India – Mega Disasters of India and Lessons Learnt
4.2 Disaster Management Act 2005.
4.3 National Policy on Disaster Management
4.4 National Guidelines and Plans on Disaster Management; Role of Government (local, state and national),Non-Government and Inter-Governmental Agencies

UNIT- V

5.1 Geo-informatics in Disaster Management (RS, GIS, GPS and RS)
5.2 Disaster Communication System (Early Warning and Its Dissemination)
5.3 Land Use Planning and Development Regulations
5.4 Disaster Safe Designs and Constructions

Books Recommended:

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