BOARD OF STUDIES IN GEOLOGY
COURSE CURICULUM FOR
M. Sc. GEOLOGY (Four Semesters Course)
Academic Session 2018-19

CHOICE BASED CREDIT SYSTEM (CBCS)

There shall be four semesters in two academic years. Semester I and III consist of Four Theory courses and two Lab courses carrying 100 marks each. Semester II consists of Four Theory papers carrying 100 marks each, Lab course I of 150 marks and the Lab course II of 50 marks. In IVth Semester, there will be Three Major/Core Theory Papers and One Major/core ELECTIVE Paper, along with respective practical. Theory papers carry 100 marks each, Lab course I carries 150 marks and Lab course II, 50 marks. Each semester carries 20 credits. Besides this, a student will have to clear two Papers of 3 credits each out of the Minor ELECTIVE courses from other Subjects/Disciplines as per his/her choice. A student will clear 80 core credits and 6 credits from choice based elective papers offered during Sem II and III. Thus, a student will have to clear total 86 credits for obtaining M. Sc. Degree.

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.

A student has to submit his choice of Major/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.

SCHEME OF EXAMINATION

SEMESTER – I CORE COURSES (2018-19)

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 (2017-18)

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 (2019-20)

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	2
Lab Course -II	Paleontology, Geomorphology and Remote sensing	100	-	100	2
	Total	520	80	600	20

SEMESTER – IV CORE COURSES (2019-20)

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
	Total credits of IV Semester				20

		Max Marks			Credits
		Theory	Internal Assmt.	Total	
	Grand Total Minor elective courses	2080	320	2400	80 06
	Total credits				86

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 (2018-19)**

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.

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

UNIT – II

2.1 Fold: Definition; Classifications - Geometrical and Genetic; Fleuty, Ramsay and Dip Isogon

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 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, compretional and strike-slip terranes

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 (2018-19)**

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) SiO2 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 (2018-19)**

UNIT – I

1.1 Cosmic Abundance of the Elements and Nucleosynthesis. Formation of Solar System and Planets. Geology and Chemistry of Moon.

1.2 Composition and Classification of Meteorites, Chondrules, Chondrites and Achondrites. Geochemical classification of elements.

1.3 Trace, Volatile, Semi volatile, Alkali and Alkaline earth elements its behaviour in magmatic processes.

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 various magmatic processes.

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

2.4 Geochemistry of Crust.

UNIT – III

3.1 Geochemistry of island arcs.

3.2 Composition of Mantle, mineralogy of lower mantle.

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

3.4 Geochemical evolution of Mantle Plume.

UNIT – IV

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

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

4.3 Redox in Natural Waters. Eutrophication.

4.4 Factors controlling Weathering. Soil profile. Chemical and biogeochemical cycling in the soil

UNIT - V

5.1 Basics of radiogenic isotope geochemistry. Scope of stable isotope geochemistry

5.2 Composition of Rivers. Composition of Seawater- Temperature variation.Density structure and deep circulation

5.3 Distribution of CO_2 in Ocean. Carbonate dissolution and precipitation.

5.4 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.

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

White, W. M. Geochemistry (Online)

SEMESTER – I **COURSE: IV - CRYSTALLOGRAPHY & CRYSTAL OPTICS (2018-19)**

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).

SEMESTER – I **PRACTICALS (2018-19)**

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 (2018-19)**

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 and Forsterite – Silica
3.2 Diopside-Albite-Anorthite
3.3 Diopside-forsterite-silica
3.4 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, Ultramafite
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 (2018-19)**

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 & Isoreactiongrade and construction of petrogenetic grids.
2.4 Concept of facies and facies series.

UNIT- III

3.1 Study of ACF, AKF and AFM diagrams.
3.2 Polymetamorphism and paired metamorphic belts.
3.3 Metamorphic differentiation.
3.4 Retrograde Metamorphism and Crystalloblastic series.
3.5

UNIT - IV

4.1 General Characters of thermal and regional metamorphism of limestone, shale and basic igneous rocks.
4.2 Metamorphism in relation to magma and orogeny.
4.3 Metasomatism-Principles and types of metasomatism. Granitization.
4.4 Anataxis, Palingenesis. Origin of Migmatites in the light of experimental studies.

UNIT-V

5.1 Kinetics of metamorphic mineral reaction. Pressure – temperature – time paths.
5.2 Ultra-high temperature and ultra-high pressure and ocean floor metamorphism.
5.3 Layering in metamorphic rocks.
5.4 Petrogenetic significance of following rocks with special reference to Indian occurrences: charnockite, amphibolite, Khondalite, Gondite, Eclogite, and Blue schist.

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 **COURSE: III - SEDIMENTOLOGY AND CRUSTAL EVOLUTION (2018-19)**

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 (2018-19)**

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.

SEMESTER – II **PRACTICAL (2018-19)**

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 (2019-20)**

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 (2019-20)**

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 **COURSE: III - GEMORPHOLOGY AND REMOTE SENSING (2019-20)**

UNIT – I

1.1 Geomorphic concepts and geomorphic cycle. Geomorphic agents: Running water, Groundwater, Glaciers, Winds, Sea waves; Geomorphic processes: Gradation, degradation-Weathering, Mass-Wasting and Erosion, aggradation. Soil formation.

1.2 Valley development, classification of valley, cycle of erosion, rejuvenation; Drainage patterns and their significance.

1.3 Fluvial landforms: Flood plain deposits, Meander belt deposits, Deltaic plain deposits, Alluvial fans and bajadas.

1.4 Glaciers: Continental and High land glaciers. Glacial erosional features: Cirque, Glacial troughs, Hanging valleys, Aretes, Truncated spurs, Fjords, Fiards, Trough lakes. Depositional features: Glacial till, glacial forms (Moraines, Drumlines), glacio-fluviatile forms (Valley trains, Eskers, Kame terraces, Kame, Kettles), glacio- lacustrine features (Lakes).

UNIT – II

2.1 Karst topography: Characteristic features of Karst (Lapies, Sink holes, Natural tunnels and bridges), Erosional remnants (Hums, Haystack hills), Depositional features of caves (Cave travertine, stalactites, stalagmites, Columns). Eolian landforms: Erosional features (Yardang), Depositional features (Dunes and Loess).

2.2 Coastal landforms: Erosional features (Headland and Bays, Cliffs and wave cut platforms, caves, arches, stacks and stumps); Depositional features (Beaches, Dunes, Berms, Spits, Bars, Tombolos and Islands). Volcanic landforms. Types of volcanoes, volcanic depressions, volcanic plateaus and plains, volcanic skeletons.

2.3 Structural landforms: Types of domal structures, topographic expression of domes; Folded structures, adjustment of topography to folded structures; Fault scarps and Fault line scarps, Horsts and Grabens, topographic expressions of various types of faults.

2.4 Terrain classification, Terrain evaluation, Drainage basin morphometry and analysis, Geomorphic regions of India.

UNIT – III

3.1 Remote sensing- active and passive, physical basis of remote sensing. Matter and EMR: electronic, vibrational and rotational transition; energy partitioning- reflection, transmission, absorption, scattering. Irradiance, Exitance, Lambertian surface. Conservation of energy principle: Reflectance, Absorptance, Transmittance.

3.2 Interaction of EMR with atmosphere: Scattering- Rayleigh, Mie, Non-selective. Atmospheric windows. Interaction of EMR with rocks and minerals: Charge transfer transition, Bond stretching transition, Bond bending transition, emissivity, selective radiators, thermal inertia.

3.3 Interaction of EMR with vegetation and water.

3.4 Platforms: Terrestrial, Aerial and Space borne. Satellite orbits: Polar and equatorial orbits. Types of satellite: Earth resource and communication satellites.

UNIT – IV

4.1 Remote sensing sensors: Photography camera, Vidicon camera, Line-scanning systems-MSS, TM, Pushbroom sensors- SPOT, IRS.

4.2.1 Microwave imaging system: Passive method- emitted energy from the earth, antenna, resolution, microwave emittance imaging. Active method- wavebands, radar, range, resolution, real aperture radar, synthetic aperture radar, slant range image, ground range image.

4.2.2 Data collection: Microwave telemetry, analogue images, picture elements and digital numbers, single band image, FCC.

4.3 Visual interpretation elements and image interpretation. Introductory digital image processing: Image histogram, Contrast stretch, Composite generation.

UNIT – V

5.1 Aerial photography: Planning and execution of photographic flights. Photogrammetry: Geometry of aerial photograps- Parallel, orthogonal and central projections, tilt. Image displacement, Parallax, Stereoscopy.
5.2 Application of remote sensing in geology
5.3 Application of remote sensing in Geomorphology
5.4 Application of remote sensing in terrain evaluation

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 (2019-20)**

UNIT- I

1.1 Prospecting & Exploration: Definition and characteristic features. Reconnaissance. Preliminary and detailed investigation, surface and subsurface methods.

1.2 Guides to ore search: global, regional and local guides, detailed study of regional physiographic, stratigraphic, lithological, mineralogical and structural guides. Persistence of ore in depth.

1.3 Drilling: Type of drills, Diamond drilling, Drilling records and logs, Duty of geologists during drilling.

1.4 Sampling: General principles, various methods and procedures, Average assays, weighting of samples, salting. Precautions.

UNIT- II

2.1 Calculating grade and tonnage of ore: Average grade, volume, specific gravity, tonnage factor, calculations from data obtained from bore holes, prospecting pits, trenches, ore blocks, geological maps and sections. UNFC classification

2.2 Gravity Method of prospecting: Basic principles of gravimeter. Gravity field surveys. Various types of corrections applied to gravity data.

2.3 Preparation of gravity anomaly maps. And their interpretation in terms of shape, size and depth.

2.4 Magnetic method of prospecting: Magnetic properties. Magnetic anomaly. Magnetometer. Field survey and data reduction. Preparation of magnetic anomaly maps. Aeromagnetic surveys.

UNIT-III

3.1 Seismic prospecting: Fundamentals of seismic wave propagation, Methods of seismic prospecting and interpretation of seismic data.

3.2 Basic principles of resistivity method. Resistivity survey. Application and interpretation of resistivity data.S.P.Method and interpretation of data obtained by S. P. Method.

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

3.4 Borehole logging: Principles of various borehole-logging methods, Interpretation of data.

UNIT- IV

4.1 Geochemical cycle, Forms of primary and secondary dispersion of elements. Secondary dispersion processes and anomalies.

4.2 Factors affecting dispersion patterns. Main types of geochemical surveys.

4.3 Methods of lithogeochemical and pedogeochemical surveys.

4.4 Methods of hydro-geochemical, atmogeochemical and biogeochemical surveys.

UNIT - V

5.1 Case studies of regional exploration for deposits of plutonic associations and vein and replacement types.

5.2 Analytical methods – sample preparation and decomposition. Precision and accuracy.

5.3 Instrumentation and applications of Atomic absorption spectrometer, Emission spectrograph and XRF.

5.4 Statistical treatment of geochemical data.

Books Recommended:

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.

SEMESTER - III **PRACTICAL (2019-20)**

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 AND ENGINEERING GEOLOGY (2019-20)**

UNIT – I

1.1 Definition of mining terms: pitting, trenching, panning, adits, tunnels, and shafts.
1.2 Role of geologist in mining industry. Strata control in different rocks and structures.
1.3 Geological structures of ore deposits and choice of mining methods.
1.4 Subsidence and rock bursts, mine supports, Ventilation and drainage.

UNIT – II

2.1 Open pit mining- geologic and geomorphic conditions, different methods of opencast mining, advantages and limitations.
2.2 Underground mining methods- gophering, shrinkage, stoping, caving and slicing sublevel, over hand, under hand methods.
2.3 Coal mining methods, long wall, board and pillar.
2.4 Engineering properties of rocks and soil. Physical characters of building stones. Metal concrete aggregate.

UNIT - III

3.1 Role of geologist in civil construction projects.
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 Classification of ground for tunneling purposes. Various types of supports.

UNIT - IV

3.1 General principles, economic justification and scope of mineral dressing.
3.2 Properties or rocks and minerals as applied to mineral dressing.
3.3 Previous and secondary breaking, crushing and grinding, liberation by sizes, reduction.
3.4 Principles and methods of screening.
3.5 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.
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.

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.

SEMESTER - IV **COURSE: II – ENVRIONMENTAL GEOLOGY (2019-20)**

UNIT- I

1.1 Definition, history and scope of Environmental Geology.
1.2 Environment, Ecology, Ecosystems and habitat.
1.3 Nature of its degradation.
1.4 Basic concepts of Environmental Geology.

UNIT- II

2.1 Interaction of man and natural systems.
2.2 Conservation principle, conservation of mineral and fuel resources.
2.3 Conservation of soil and water resources.
2.4 Geological hazards- Lands slides, volcanic activity, Earthquake.

UNIT- III

3.1 Draught and desertification, Measures of mitigation.
3.2 Geological hazards -River flooding, erosion and sedimentation, coastal erosion, cyclones and tsunamis.
3.3 Transgression and Regression of sea. Measures of mitigation.
3.4 Human modifications of nature in surface and subsurface by engineering constructions dams, reservoirs, bridges and buildings.

UNIT - IV

4.1 Changes in surface and subsurface by mining activities.
4.2 Changes in surface and subsurface by mineral based industries.
4.3 Human settlement and contamination of atmosphere, soil, surface water and groundwater by waste disposal and agro-industries.

UNIT- V

5.1 Environmental policies of the Government for air and water pollution. Environmental laws.
5.2 Problems of environment in urban areas, causes and remedies.
5.3 Climate Change and global warming: Causes and Impact (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.

SEMESTER - IV **COURSE: III – HYDROGEOLOGY (2019-20)**

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

SEMESTER - IV **PRACTICAL (2019-20)**

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.

SEMESTER - IV **CORE ELECTIVE COURSES (2019-20)**

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,

SEMESTER - IV **(2019-20)**

ME-II PROJECT ORIENTED DISSERTATION

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

MINOR ELECTIVE

GMnE- I FUNDAMENTALS OF GEOLOGY

UNIT- I

1.1 Geology and its perspective. Earth in the Solar System
1.2 Age of the earth.
1.3 Interior of the earth and its manifestation.
1.4 Brief introduction of hydrosphere and atmosphere. Hydrologic cycle.

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. Tectonic divisions of India

UNIT- III

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

UNIT- IV

4.1 Geomorphic agents, Weathering.
4.2 Salient geomorphic features.
4.3 Types mountains and plains
4.4 Fossils and their applications

UNIT- V

5.1 Industrial uses of Iron, Manganese, Bauxite
5.2 Industrial uses of Copper, Lead and Zinc
5.3 Fossil Fuels: Coal and Petroleum- mode of occurrence and distribution in India
5.4 Conservation of energy and 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.

MINOR ELECTIVE

GMnE- II DISASTER MANAGEMENT

UNIT- I

1.1 Natural Disasters: Introduction
1.2 Causes and impact of Floods, Droughts,
1.3 Cyclone, Landslides,
1.4 Earthquake and Tsunamis

UNIT- II

2.1 Man-made Disasters: introduction
2.2 Causes and impact of Nuclear, Industrial accidents,
2.3 Environmental disasters, fires, rail accidents, road accidents,
2.4 Air accidents and sea accidents

UNIT – III

3.1 Hazard Risk Concept and Elements.
3.2 Risk Analysis and Risk Assessment.
3.3 Resource Analyses and Mobilisation.
3.4 Strategic Developments for Vulnerability Reduction

UNIT- IV

4.1 Disaster Preparedness: Conception and Nature.
4.2 Disaster Management – Prevention, Preparedness and Mitigation.
4.3 Search and rescue operations
4.4 Use and Applications of Emerging Technologies in Disaster Preparedness.

UNIT- V

5.1 Disaster Management Plan
5.2 Disaster Response Plan.
5.3 Communication, Participation, and Activation of Emergency Preparedness Plan.
5.4 Logistics Management.

Books Recommended:

Bell, F.G. (1999): Geological Hazards, Routledge, London.
Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press.
Keller, E.A. (1978): Environmental Geology, Bell and Howell, USA.
Lal, D. S. (2007): Climatology, Sharda Pustak Bhawan, Allahabad.
Patwardhan, A.M. (1999): The Dynamic Earth System, Prentice Hall.
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