

SCHOOL OF ENVIRONMENTAL SCIENCES
MAHATMA GANDHI UNIVERSITY, KOTTAYAM

Department of Geology

Credit and Semester System

Scheme & Syllabus for

MSc. Applied Geology (2022 admission onwards)

Semester I

| Sl No. | Course Code | Name of the Course | Credits | Credits Required | Total Credits |
|--------|-------------|--|---------|------------------|---------------|
| 1 | GE M 22 C01 | Applied Mineralogy | 4 | 18 | 24 |
| 2 | GE M 22 C02 | Structural Geology and Tectonics | 3 | | |
| 3 | GE M 22 C03 | Geochemistry & Isotope Geology | 4 | | |
| 4 | GE M 22 C04 | Applied Geomorphology & Geoinformatics | 4 | | |
| 5 | GE M 22 C05 | Lab Course: I (Geomorphology, Structural Geology and Mineralogy) | 3 | | |
| 7 | GE M 22 E01 | Ecology, Energy & Environment | 2 | 6 | |
| 8 | GE M 22 E02 | Research Methodology & Geostatistics | 2 | | |
| 9 | GE M 22 E03 | Meteorology & Climatology | 2 | | |

Semester II

| Sl .No. | Course Code | Name of the Course | Credits | Credits Required | Total Credits |
|---------|-------------|---|---------|------------------|---------------|
| 10 | GE M 22 C06 | Igneous and Metamorphic Petrology | 4 | 20 | 24 |
| 11 | GE M 22 C07 | Sedimentology & Marine Geology | 4 | | |
| 12 | GE M 22 C08 | Stratigraphy & Palaeontology | 3 | | |
| 13 | GE M 22 C09 | Analytical Geochemical Techniques and Instrumentation | 3 | | |
| 14 | GE M 22 C10 | Geospatial Data Analysis | 3 | | |
| 15 | GE M 22 C11 | Lab Course: II (Petrology & Geochemistry) | 3 | | |
| 16 | GE M 22 E04 | Geological Field Mapping | 2 | 4 | |
| 18 | GE M 22 E05 | Concepts of Disaster Management | 2 | | |

Semester III

| Sl .No. | Course Code | Name of the Course | Credits | Credits Required | Total Credits |
|---------|-------------|--|---------|------------------|---------------|
| 19 | GE M 22 C12 | Exploration Geology and Geophysics | 4 | 20 | 24 |
| 20 | GE M 22 C13 | Ore Geology and Indian Mineral Deposits | 4 | | |
| 21 | GE M 22 C14 | Engineering Geology | 3 | | |
| 22 | GE M 22 C15 | Coal and Petroleum Geology | 3 | | |
| 23 | GE M 22 C16 | Hydrogeology | 3 | | |
| 24 | GE M 22 C17 | Lab Course III (Practical applications of geoinformatics in Geosciences) | 3 | | |
| 25 | Open course | | 4 | 4 | |

Semester IV

| Sl. No. | Course Code | Name of the Course | Credits | Credits Required | Total Credits |
|---------|-------------|------------------------------|---------|------------------|---------------|
| 26 | AG M 22 C19 | Internship | 4 | 4 | 16 |
| | AG M 22 C20 | Project Work (Report/Thesis) | 12 | 12 | |

SYLLABUS

MSc. Applied Geology

SEMESTER – I

| Course Code | Course Name | Credits |
|-------------|--------------------|---------|
| GE M 22 C01 | Applied Mineralogy | 4 |

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| UNIT I |
| Crystalline state, symmetrical lattice, Bravais lattice, point groups and their symmetry. |
| UNIT II |
| Silicate structure – co-ordination number and silicon tetrahedra. Nesosilicates: Olivine- Fo-Fa series, structure, properties, paragenesis and P-T stability; Garnet-structure, chemistry, properties and paragenesis; Al_2SiO_5 polymorphs. Sorosilicates: Melilite- composition and structure. Inosilicates: Single chain- Pyroxenes- T-O-T beam structure and classification; orthopyroxene- Enstatite-Ferrosilite series- properties and paragenesis. Clinopyroxenes – Ca-, Ca-Na- and Na-, chemistry, properties and paragenesis. Double chain- Amphiboles- orthoamphiboles and clinoampbiboles– chemistry, structure, properties and paragenesis. |
| UNIT III |
| Cyclosilicates: Cordierite, Tourmaline and Beryl- chemistry, structure, properties and paragenesis. Phyllosilicates: Sheet structure- Brucite and Gibbsite sheet, TO, TOT, TOT+c and TOT+Ostructures. Clay and mica- chemistry, structure, properties and paragenesis. Tectosilicates – Silica group; structure, P-T stability of SiO_2 polymorphs; Feldspars– structure and classification, Plagioclase and Alkali feldspars- properties and paragenesis. Solid solution and exsolution, intergrowths –Perthite, myrmekite, graphic and rapakivi and its significance; twinning in feldspars- simple and polysynthetic. |

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| UNIT IV |
| Principles of mineral optics- Birefringence. Optical accessories and their uses. Conoscopic study and interference figures. Dispersion in minerals. Procedure for determining 2V (Mallards method), optic sign, scheme of pleochroism and sign of elongation. |
| UNIT V |
| Principles of X- ray diffraction, Bragg's law, Basic feature of X- ray diffractometer, single crystal and powder methods. Preparation of sample for XRD study and interpretation of data. Basic principles of EPMA analysis. |

References

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| 1 | Ford, W. H. (1955) A text book of Mineralogy- Asia publishing House – Wiley. |
| 2 | Phillips, (1956) An Introduction to Crystallography – Longmans Green |
| 3 | Cornelis Klein and Hurlbut (1985) Manual of Mineralogy, John Wiley |
| 4. | Deer, W. A., Howie, R.A and Zussman, J. (1992) An introduction to the rock-forming minerals, ELBS –Longman, England. |
| 5 | Hans- Rudolf Wenk & Andrei Bulakh (2004) Minerals – their constitution and origin, Cambridge University press. |
| 6 | Nesse, W. D. (1999) Introduction to Mineralogy, Oxford University Press, New Delhi. |
| 7 | Perkins D. (2002) Mineralogy, Prentice-Hall of India Pvt Ltd, New Delhi. |

| Course Code | Course Name | Credits |
|-------------|----------------------------------|---------|
| GE M 22 C02 | Structural Geology and Tectonics | 3 |

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| UNIT I |
| Deformations- homogenous and heterogenous deformation- elastic and plastic deformation. Concept of stress and strain – types of stress – lithostatic, compressive and tensile stress. Normal and shear stress. Strain– dialation and distortion. Stress and strain ellipsoids, stress strain graphs- concepts of Flinn Diagram & Mohr's Circle. Nature of rocks and minerals under stress – brittle and ductile conditions. |
| UNIT II |

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| Fold- Cylindrical and non-cylindrical folds. Classification of folds - Ramsay's classification, Donath and Parkers classification. Drag folds – minor folds and their use in determining major fold structure. Mechanics of folding. Superimposed folds and interference patterns. |
| UNIT III |
| Fault systems related to plate tectonic domains. Shear zone – types, geometry and mechanism of formation. Brittle and ductile shears and associated structures. Thrust – large scale thrust and their tectonic significance. Mapping of structural features. Tectonites - classification, tectonic fabrics. Foliation – definition and types. Fracture cleavage and transposed foliation. Origin of axial plane foliation. Use of axial plane foliation and fracture cleavage in structural interpretation. Lineation – classification and origin. |
| UNIT IV |
| Spatial orientation of planar and linear fabrics. Fundamentals of geometric analysis. Petrofabric analysis – field and laboratory techniques involved in the construction of fabric diagrams and their interpretation. Graphical representation of structural data – stereographic and equal-area projections in structural geology – π and β diagrams, histogram and rose diagram. |
| UNIT V |
| Geodynamic settings of plate margins. Tectonic framework of Indian plate- Evolution of Himalaya, Central Indian Tectonic Zone (CITZ). Supercontinents- Indian plate journey through Rodinia, Gondwana and Pangaea. Tectonic framework of Southern Granulite Terrain (SGT). |

References

- 1 Davis, G.H., Structural Geology of Rocks and Regions, John Wiley and Sons, 1984.
- 2 Hills, E.S. Elements of Structural Geology, I Edition, Asia Publishing House, 1965.
- 3 Hobbs, B.E., Means, W.D. and William, P.F. An Outline of Structural Geology, JohnWiley 1976.
- 4 Twiss R.J., and Moores E.M., Structural Geology, W.H. Freeman and Company, 1992.
- 5 Gokhale, N.W., Theory of structural geology, CBS Publishers, 1996.
- 6 Philips, F.C., Stereographic Projection in Structural Geology, II Edition, Arnold, 1969.
- 7 Ragan, D.M. Structural Geology, I Edition, Wiley, 1969.
- 8 Spencer, E.P. Introduction to the Structure of the Earth, I Edition, Mc Graw Hill, 1969.
- 9 Jaroszewski, W. and Kirk, W.L., Fault and fold tectonics, Ellis Horwood Ltd, 1984.
- 10 Turner, F.J. and Weiss, L.E., Structural Analysis of Metamorphic Tectonites, I

- Edition, Mc Graw Hill, 1963.
- 11 Whitten, E. H. T., Structural Geology of Folded Rocks, II Edition, Rand Mc Nelly, 1969.
- 12 De Sitter, L.U., Structural Geology, McGraw-Hill Book Company, 1956.
- 13 Ramsay, J. G. and Huber, M. I., The techniques of modern structural geology, Volume 1,2 and 3: Strain analysis, Academic press, 1983
- 14 Naqvi, S.M. and Rogers, J.J.W., 1987, Precambrian geology of India, Oxford University Press.
- 15 Ramakrishna, M. (ed.), 2003, Tectonics of southern granulite terrain, Kuppam-Palani Geotransect, JGSI Memoir 50.
- 16 Radhakrishna, T and Piper, J. D. A., (ed.), The Indian Subcontinent and Gondwana: A Palaeomagnetic and Rock Magnetic Perspective, JGSI Memoir 44.
- 17 Park, R. G., 2013, Foundations of Structural Geology, Routledge Publishers

| Course Code | Course Name | Credits |
|-------------|--------------------------------|---------|
| GE M 22 C03 | Geochemistry & Isotope Geology | 4 |

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| UNIT I |
| Origin and cosmic abundance of elements. Geochemical classification of elements. Geochemical cycles. Chemical evolution of the earth. Primary geochemical differentiation. Classification of meteorites. Geochemical constitution of earth's crust, mantle, core and meteorites. Phase transitions in the mantle. Goldschmidt's rules. Nernst's partition coefficient (compatible and incompatible elements), LILE and HFSE. Major, minor and trace elements, REEs and PGEs. |
| UNIT II |
| Laws of thermodynamics. Equations of State. Standard states. Enthalpy, entropy, heat capacity, changes in enthalpy and entropy with P and T, Gibbs free energy and equilibrium. Clapeyron equation. Simple thermodynamic calculations involving phase changes and equilibrium reactions. |
| UNIT III |
| Geochemistry of igneous rocks- Behavior of major and minor elements during magmatic crystallization, Goldschmidt's rules, Transition and trace element geochemistry. Geochemistry of sedimentary rocks- Goldich's stability series, physico-chemical factors in sedimentation, ionic potential, colloidal processes. |
| UNIT IV |
| Introduction to isotope geology: Isotopes, isobars and isotones, stable and radioactive isotopes. Various decay mechanisms- alpha, beta (positron and negatron), gamma decay, electron capture and branched decay. Radioactive decay, half-life and basic equation for age calculation. |

UNIT V

Study of different radioactive systematics: Rb-Sr , Sm-Nd systematics, U-Th-Pb systematics, K-Ar systematics, Fission track method of dating. Cosmogenic radionuclides and their applications- ^{14}C method of dating.

Stable isotope studies- Isotope fractionation, Delta notation and its significance, significance of stable isotopes of Carbon, Oxygen and Sulphur in petrology.

References

1. Albarede F. (2003) Geochemistry- An introduction, Cambridge university press.
2. Gill, R. (1989) Chemical fundamentals of geology, Unwin Hyman, London
3. Krauskopf, E.B. (1979) Introduction to geochemistry, McGraw Hill Book Company, New Delhi.
4. Mason, B. and Moore, C.B. (1985) Principles of geochemistry, Wiley Eastern Ltd, Bangalore.
5. Faure G. (1986) Principles of isotope geology1, John Wiley & Sons
6. Faure, G., Mensing, T. M., Tsotopes – Principles ans Applications, Wiley India Pvt. Ltd.,New Delhi

| Course Code | Course Name | Credits |
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| GE M 22 C04 | Applied Geomorphology & Geoinformatics | 4 |

UNIT I

Basic concepts of geomorphology – ancient and modern ideas. Geomorphological cycle –Davis and Penck, King, Hack and Gilbert models.

UNIT II

Fluvial Geomorphology – Channel morphology-Channel geometry-Chanel length, width, bends slopes thalweg and wetter parameter;
Wind erosion and deposition. Landforms of arid, semi-arid, and savanna regions Perigacial and glacial morphogenesis. Mechanisms of erosion and transportation by moving ice. Continental and alpine glaciation. Glacial landforms. Permafrost and periglacial landforms.

UNIT III

.Coastal and Marine Geomorphology. Shore zone processes and landforms. Classification of coasts. Sea level fluctuations. Submarine processes and landforms.

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| UNIT IV |
| <p>Remote sensing: Introduction</p> <p>Remote sensing system – components and principles – platforms, sensors, medium, target, interactions and their characteristics including various resolutions, concept of DN value, radiance, reflectance, emission</p> <p>Electromagnetic spectrum - energy interaction with atmosphere and earth surface, atmospheric windows, spectral properties of various objects on the earth’s surface and the concept of spectral signature, active and passive remote sensing.</p> <p>Space borne earth observation: various orbits and their characteristics, operations, image acquisition and various data products</p> <p>Indian remote sensing programme& Other satellites and sensors like Landsat, SPOT, etc.</p> |
| UNIT V |
| <p>Geodetical aspects, mapping concepts and surveying</p> <p>Earth System – Geodesy: Datum/Spheroids and coordinate systems, map projection - different projections and their characteristics</p> <p>Features on the earth’s surface: their basic properties – discrete vs continuous and geometries of representation</p> <p>Cartography: Maps – their characteristics and elements, types - Basic surveying principles and techniques: EDMs and GNSSs; GNSSs – segments, various constellations, errors, differential correction and precise positioning. Map reading and interpretation</p> <p>Global, national and state mapping agencies and their authorized reference maps – general & thematic</p> |

References

- 1 R.J. Huggest (2007) Fundamentals of Geomorphology. Routledge Publishers
- 2 A.S. Goudie (2004), Encyclopedia of Geomorphology (Vol. 1&2). Routledge Publishers.
- 3 D.W. Burbank & R.S. Anderson (2001), Tectonic Geomorphology, Blackwell Science, Publishers.
4. A.L. Bloom (1992) Geomorphology – A systematic analysis of ate Cenozoic landforms. PHI, New Delhi.
- 5 M.A. Summerfield (1991), Global Geomorphology, Pearson Education Ltd.

- 6 W.D. Thornbury (1969) Principles of Geomorphology. Willey Eastern Ltd. New Delhi.
- 7 H.S. Sharma (1990) Indian Geomorphology. Concept Pub. Co., New Delhi.
- 8 Ahmad, E. Coastal Geomorphology of India, Orient Longman, New Delhi, 1972
9. Holmes, A. Principles of Physical Geology, Ronald, New York, 1965.
- 10 King, C.A.M Beaches and Coasts, Arnold, London, 1972.
- 11 Leopold, L, Wolmen, C, Miller, J.P., 1963 Fluvial Processes in Geomorphology, Freeman.
- 12 Ritter, DF, Kochel, RC and Miller, JR. Process Geomorphology, Wm.C. Brown Publishers, 1995
- 13 Sparks, BW. Geomorphology, Longman, London, 1979
- 14 Chorley, RJ, Schumm, SA and Sugden, DE. Geomorphology, Methuen & Co., 1984

| Course Code | Course Name | Credits |
|-------------|--|---------|
| GE M 22 C05 | Lab Course: I (Geomorphology, Structural Geology and Mineralogy) | 3 |

GEOMORPHOLOGY

Geomorphology: Toposheet reading, Preparation of drainage map, Preparation Contour map, Morphometry, Preparation of drainage, Preparation of drainage density map, Preparation of drainage frequency map, Preparation of Relative Relief map. Drainage pattern analysis.

MINERALOGY

Stereographic projection of Normal class of Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic, Triclinic System and Rhombohedral class.

Identification of typical mineral hand specimens based on physical properties. Determination of the following optical characters of minerals: Order of Interference colour, Sign of Elongation, Optic sign Scheme of Pleochroism, Optic orientation, Optic axial angle and Extinction Angle.

STRUCTURAL GEOLOGY

Interpretation of complex geological maps

Trigonometric and stereographic solution to problems in structural geology (unconformities, fold and fault). Geometric analysis of planar and linear structures,

Fabric diagrams, Rose diagrams, Histograms, β diagram and π diagram, strain analysis.

| Course Code | Course Name | Credits |
|-------------|-------------------------------|---------|
| GE M 22 E01 | Ecology, Energy & Environment | 2 |

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| UNIT I |
| Basic concepts of Environment – Multidisciplinary approach Basic concepts - Science, Matter and Energy Evolution of earth, origin of species, diversity and distribution of species Global environmental issues – an introduction |
| UNIT II |
| Ecology Definition, History of ecology, Subdivisions, Ecology and other subjects. Fundamental ecological variables. Ecosystems: Definition, Components, Structure and function and size. Classification of ecosystems. Comparative Ecosystem Ecology |
| UNIT III |
| Chemistry of the environment – basics Mass and Energy transfer across the various interfaces, material balance. First and Second law of thermodynamics. Heat transfer processes, Chemical potential; Chemical equilibria, acid· base reaction. Solubility product, solubility of gases in water, the carbonate system. Unsaturated and saturated hydrocarbons, radionuclide's |
| UNIT IV |
| Atmospheric chemistry The atmosphere Composition of Air: Classification of elements, chemical speciation. Particles, ions and radicals in the atmosphere. Chemical and photochemical reactions in the atmosphere, reactions of atmospheric oxygen Chemical processes for formation of inorganic and organic particulate matter. Chemistry of air pollutants, Photochemical smog. Energy transfer in atmosphere, Global climate and microclimate. |
| UNIT V |
| Aquatic Chemistry Fundamentals of aquatic chemistry, The importance of water, The properties of water, gases in water Calcium and other metals in water, Polyphosphates and phosphonates in water. Concept of DO, BOD, COD, sedimentation, coagulation, · filtration, Redox potential. |

References

1. Brewer,R.(1994), The Science of Ecology, Saunders College Publishing, New York.
2. Chapman, J. L. And Reiss, M. J. (1992), Ecology: Principles and Application, Cambridge University Press, Cambridge.
3. David T. Allen, Green Engineering: Environmentally Conscious Design of Chemical Processes
4. Groombridge, B. (ed) 1992. Global Biodiversity: Status of the Earth's Living Resources, Chapman and Hall, London.
5. Hughes, J,D. 2001. An Environmental History of the World. Routledge, London.
6. James Girard, Principles of Environmental Chemistry
7. M. N. Rao and H V N Rao, Air Pollution, Mc GRAW HILL
8. Manahan Stanley E ., Environmental chemistry, Lewis Publishers London
9. Michael, P. 1990. Ecological methods for Laboratory and Field Investigations, Tata McGrew Hill Publishing Company Ltd, New Delhi.
10. Odum,E.P. 1971. Fundamentals of ecolog

| Course Code | Course Name | Credits |
|-------------|--------------------------------------|---------|
| GE M 22 E02 | Research Methodology & Geostatistics | 2 |

| UNIT I |
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| <p>Research Methodology: Objectives- motivation- Significances of research, Types of research, Research methods and methodology, Research and Scientific Method, Criteria of Good research, Problems of researcher</p> <p>Selection of the problem: Criteria for selection of problem and evaluating problems, Statement of problem formulation and definition.</p> <p>Research design: Meaning, need for research design, Features and important concepts relating to research design, Different research design, Basic principles of experimental design.</p> |
| UNIT II |
| <p>Survey of literature: Different methods of surveying literature, different sources of information, internet, search engines, web sites, recording surveying information.</p> <p>Hypothesis: Nature, types and sources of hypothesis, characteristics of a good hypothesis.</p> |

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| Sampling: Unit of sampling, population: techniques, characteristics of good samples, different types of sample, sampling errors and ways to reduce them. |
| UNIT III |
| Collection and analysis and interpretation of data: Procedure of data collection, scoring of data, tabulation, editing and analysis and interpretation of data. |
| Research Report: Composition, pagination, Title pages, Systems of indicating references, Bibliography, Appendices |
| UNIT IV |
| Fundamental Statistics, Classification and Tabulation of data, Graphical Representation |
| Measures of Central Tendencies – Mean, Median and Mode |
| Measures of Dispersion - Range, Standard Deviation and Co-efficient of Variation, Moments, Skewness and Kurtosis |
| UNIT V |
| Correlation and Regression – Scatter diagrams – Karl Pearson’s Coefficient of correlation – Rank correlation – Linear and Curvilinear regressions. |
| Probability – Frequency approach- Addition and multiplication theorems- Binomial, Poisson and Normal Distribution- Probit analysis |
| Testing of Hypothesis: Null and Alternative Hypothesis – Two types of error – Level of significance Test based on t, Z, F, Chi –square and Analysis of Variance – one-way, two-way, three-way analysis. |
| Introduction to various computer softwares for statistical applications. |

References

1. Ahuja Ram, Research Methods, Rawath Jaipur.
2. Babbie Earl, Research methods in sociology, Cengage Learning Australia.
3. Davis: Statistics and Data Analysis in Geology (3rdEdn.), John Wiley and Sons
4. Denscombe Martyn, The good research guide: for small scale social research projects, Viva Books New Delhi.
5. Devendra Thakur, Research methodology in social science, Deep & Deep Publications New Delhi
6. Freund: Mathematical Statistics. Prentice Hall of India
7. Gupta and Kapoor: Fundamentals of Mathematical Statistics. Sultan Chandra and Sons
8. Gurumani N, Research methodology for Biological Sciences, MJP Publishers Chennai

9. Holmes Debbie Moody Peter Dine Diana, Research methods for the biosciences, Oxford New york.
10. Kothari C R, Research methodology: methods and techniques, Wiswa Prakashan New Delhi.
11. Mohankumar P S , Handbook on research methodology, Right Publishers Kudanechoor
12. Narwal S S Dahiya S S Singh J P, Research methods in Plant science, Allelopathy Vol 1, Soil analysis, Scientific Publishers Jodhpur.
13. Pal: Statistics for Geoscientists. Concept Publishing Company
14. Prabhakar V K, Research methodology and system analysis, Anmol New Delhi
15. Santosh Gupta, Research methodology and statistical techniques, Deep & Deep Publications New Delhi
16. Barnett Vic, Environmental statistics, methods and applications. JhonWiley & Sons New York.
17. Gupta S P, Statistical methods, Sultan Chandh New Delhi
18. Kozak Antal Kozak Robert A Staudhammer Christina L Watts Susan B, Introductory Probability and Statistics, applications for forestry and the natural sciences, Cab International Wallingford.
19. Levin Richard I Rubin David S, Statistics for Management, Edition 7, P H I New Delhi
20. Miller Jane, Statistics for advanced level, Ed.2, University Press Cambridge

SEMESTER II

| Course Code | Course Name | Credits |
|-------------|-----------------------------------|---------|
| GE M 22 C06 | Igneous and Metamorphic Petrology | 4 |

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| UNIT I |
| Magma characteristics- physical properties. Diversification of magma- AFC process. Magma generation in relation to tectonic setting- Mid ocean ridge volcanism, subduction related volcanism (Island arc and continental arc volcanism), Oceanic intraplate volcanism and continental flood basalts. Large Igneous Provinces with Deccan Basalt Province as example. |
| UNIT II |
| Elementary thermodynamics, Phase rule in igneous petrology and three component systems: Ternary eutectic system- Di-An-Fo system, Ternary system with solid solution- Di-An-Ab system, Ternary peritectic system- Fo-Qtz-An system, Ternary system with solvus- Ab-Or-Anorthite system. |
| UNIT III |
| Mineralogy, texture mode of occurrence and genesis of basalts. Basalt tetrahedron (Yodder and Tilley). Ophiolite sequence and its significance. Continental alkaline magmatism: Mineralogy, texture, mode of occurrence, genesis and economic importance of Carbonatites, Lamprophyres, Kimberlites and Komatiites. Mineralogy, texture, mode of occurrence and genesis of granites and granitoids. Brief description of granites in the South Indian shield. Layered igneous complex and their significance. Sittampundi layered complex, South India. Anorthosites: Massif and layered types, origin and tectonic significance. Intrusives of Kerala- distribution, petrography, geochemistry, tectonic setting, age and petrogenesis. |
| UNIT IV |
| Elementary thermodynamics and phase rule in metamorphic petrology. Metamorphic facies-Zeolite, Prehnite, pumpellyite, green Schist, amphibole, granulite, blue schist, eclogite; Facies Series; Metamorphism of Pelitic Mafic and Carbonate Rocks. UHP and UHT Metamorphism; Pressure-Temperature-Time (P-T-t) paths. Facies and their development. Mineral paragenesis and chemographic diagrams- ACF, AKF and AFM diagrams – merits and demerits. Schreinmaker's rule and petrogenetic grid. |
| UNIT V |
| Granulite facies rocks with special references to charnockites and khondalites of South India. Fluid inclusions, importance of fluid inclusion in metamorphic studies. Metamorphic reactions-Polymorphic transformations, exsolution reactions, solid-solid net transfer reactions, continuous reactions, devolatilization reactions, ion exchange |

reactions, oxidation/reduction reactions and reaction involving volatile species. Geothermobarometry– basic concept. Metamorphism in relation to plate tectonics - paired metamorphic belts. Polymetamorphism, metasomatism, granulization and migmatites.

References

- 1 Barth, T.F.W., 1962, Theoretical Petrology, Wiley, Edition 1, Dover Publication.
- 2 Bowen, N. L. (1956) The Evolution of the Igneous Rocks. Dover publication, Inc, New York.
- 3 Ehler, G. E. and Blatt H., 1999, Petrology-Igneous, sedimentary and metamorphic, CBS Publishers and distributors, New Delhi
4. Gupta, A. K., (1998), Igneous rock. Allied Publishers Ltd, Chennai
- 5 Johanson, 1952, Manual of Petrographic Methods, Mc Graw Hill.
- 6 Mason, R., 1990, Petrology of the metamorphic rocks, Unwin Hyman, London
- 7 Middlemost E.A.K. (1985) Magmas and Magmatic rocks, Longman, New York.
- 8 Mihir K. Bose (1997), Igneous petrology, The World Press Private Ltd, Calcutta
9. Miyashiro, A., 1972, Metamorphism and Metamorphic Belts, Allen and Unwin.
- 10 Philipots A. (1994) Principle of Igneous and metamorphic petrology, Prentice Hall of India Pvt Ltd, New Delhi.
- 11 Philipots, A., and Ague, J. J., (2011) Principles of Igneous and metamorphic petrology, Cambridge publishers
- 12 Ramakrishan and Vaidyanathan (2008) Geology of India, Geo. Soc. India, Bangalore
- 13 Soman, K., (2004) Geology of Kerala, Geological society of India, Bangalore
- 14 Subramanian K.S. & Selvan, T.A. (2001) Geology of Tamil Nadu, Geo Soc India, Bangalore.
- 15 Turner, F.J. and Verhoogen, J., 1999, Igneous and metamorphic petrology
- 16 Tyrrell, G.W., 1987, The principles of petrology, B. I. Publications PVT LTD.
- 17 Wilson, M. (1989) Igneous Petrogenesis. Unwin Hyman Inc., USA
- 18 Winkler, H.G.F., 1979, Petrogenesis of metamorphic rock, Springer-Verlag
- 19 Winter, J.D. (2001) An introduction to igneous and metamorphic petrology, Printice Hall, New Jersey.

| Course Code | Course Name | Credits |
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| G M 22 C07 | Sedimentology & Marine Geology | 4 |

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| UNIT I |
| <p>Sedimentary processes- weathering, sediment transported by fluids - fundamentals of fluid flow- open channel flow- laminar flow, turbulent flow- Reynolds number, Froude Number, particle entrainment. Particle settling velocity- Stoke's law. Sediment load, process of sediment transport- by fluids, gravity and flow velocity.</p> <p>Depositional environments –Facies: Terrestrial-Fluvial, glacial, Aeolian and lacustrine systems. Transitional- deltaic, beach and barrier island, estuarine and tidal flat systems. Marine- Shallow and deep marine systems.</p> |
| UNIT II |
| <p>Classification of sedimentary rocks; Siliciclastic rocks – conglomerates, breccia, sandstones, mud rocks- their description, classification and diagenesis. Biogenic, chemical and other nonsiliclastic rocks – carbonate rocks- types, classification and their diagenesis. Siliceous, phosphatic and iron-rich and evaporate sediments and sedimentary rocks- varieties and environments of formation</p> <p>Textural study of sediments- Techniques of grain size measurement- Sieve analysis, Settling Analysis- sedimentation balance.</p> <p>Sedimentary structures– origin, classification-primary, secondary and organic structures; palaeo- environmental significance of sedimentary structures</p> |
| UNIT III |
| <p>History of Marine Geology, Scope and Applications of Marine Geological Investigations. Oceanic expeditions: Challenger expedition, Deep Sea drilling Project, Ocean drilling Programme, Joint Global Flux Studies (JGOFS), Integrated Ocean Drilling Programme (IODP).</p> |
| UNIT IV |
| <p>Ocean Floor topography-- Continental margins: continental shelf and slope, its origin, continental rise; Submarine canyon and their origin, Oceanic ridges: Ridges, fracture zones; Ocean basins: Abyssal plains, Abyssal hills, Seamounts and guyots, Marginal trenches.</p> <p>Methods of exploring the ocean floor: Sub bottom Geological sampling equipments – Snappers or grabs, Corers : Gravity , Piston, Spade, Vibratory, corers. Dredges, underwater photography and diving.</p> |
| UNIT V |
| <p>Evolution of Oceans: Structure and evolution of Pacific, Atlantic and Indian Oceans, Red Sea and Mediterranean Sea.</p> <p>Sea level changes, causes and types of sea level changes</p> |

References

- 1 Blatt, Middleton, and Murray: Origin of Sedimentary Rocks, Prentice Hall, 1972.
- 2 Boggs, S. Jr., 2010, Principles of Sedimentology and Stratigraphy, Pearson Education, Inc.
- 3 Carver (Ed.) Procedures in Sedimentary Petrology, John Wiley, New York 1971
- 4 Folk: Petrology of Sedimentary Rocks, Hempill's, Texas, 1968
- 5 Gary Nichols: Sedimentology and Stratigraphy (Second Edn.) ,Wiley Blackwell, 2009
- 6 Krumbein and Pettijohn: Manual of Sedimentary Petrography, Appleton Century Co.,1938.
- 7 Pettijohn, Potter and Siever: Sand and Sandstone , Springer Verlag, 1972.
- 8 Pettijohn: Sedimentary Rocks, Harper and Row ,1957
9. Pickering, Hiscott and Hedn: Deep Marine Environments – Clastic Sedimentation and Tectonics, Unwin and Hyman, 1989.
- 10 Prothero and Schwab: Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy, Freeman and Company, New York, 1996
- 11 Selley: Ancient Sedimentary Environments, Corwell University Press, 1972.

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| 1. Marine Geology | J.P.Kennet |
| 2. The earth beneath the sea | Shepard F.P. |
| 3. Submarine Geology | Shepard F.P. |
| 4. The Ocean floor. | Hams petterson |
| 5. Plate Tectonics and crustal evolution | Condia K.C. |
| 6. Petrology of the ocean floor. | R.Hekinin |
| 7. Geotectonics | Belonssov V.V |

| Course Code | Course Name | Credits |
|--------------------|---------------------------------------|----------|
| GE M 22 C08 | Stratigraphy and Palaeontology | 3 |

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| UNIT I |
| Stratigraphic Principles and Evolution: Chronostratigraphy, Biostratigraphy and Lithostratigraphy, stratigraphic correlation. Evolution of Geological Time Scale. Procedures in seismic stratigraphy, magneto-stratigraphy, and sequence stratigraphy. |

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| Major geological events in Phanerozoic Eon. Major extinction events in Phanerozoic. K-T Boundary extinction and its causes. Volcanic eruption and Meteorite impact hypothesis |
| UNIT II |
| Precambrian stratigraphy: Precambrian Crust- Nature and evolution of primitive crust and characteristic features of Achaean crust. Detailed study of Precambrian stratigraphy in India with special references to SGT, Dharwar, Bastar, Singhbhum, Aravalli and Bundelkhand Cratons. Mobile belts in India – Pandyan, Eastern Ghats, Satpura and Aravalli mobile belts. Evolution and stratigraphy of Proterozoic sedimentary basins of India – Cuddapah, Vindhyan, Kurnool. |
| UNIT III |
| Phanerozoic stratigraphy of India- Palaeozoic Stratigraphy of Kashmir and Kumaon. Stratigraphy and evolution of Deccan Volcanic Province, Gondwana Super group. Cenozoic of Bengal basin. Boundary problems- Permian-Triassic and Cretaceous-Tertiary with special references to India. |
| UNIT IV |
| Invertebrate Paleontology: An overview. Morphology, classification, evolutionary trend, composition and structure of shells of selected groups of organisms - A brief study of morphology, geological history and geographical distribution of Brachiopoda, Pelecypoda, Cephalopoda, Gastropoda, Echinoidea, Trilobita, Coelenterata and Graptoloidea. |
| UNIT V |
| Vertebrate Palaeontology: Introduction, Brief study of vertebrate life through ages. General evolution of reptiles and mammals. Indian pre-Tertiary vertebrate - their distribution and paleogeographic implication; extinction of dinosaurs. Indian Tertiary vertebrate - Siwalik mammals; phylogeny - Equidae & Proboscidae. Indian fossil Hominoidea and modern theories regarding human evolution. |

References

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8. Kay and Colbert. Stratigraphy and Life History, Wiley, 1965.
9. Krumbein, W.C. and Sloss, L.D. Stratigraphy and Sedimentation, Freeman, 1963.
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11. Moore, R.C., Lalicker, C.G. and Fisher, A.G.: Invertebrate Fossils. McGraw Hill
12. Nicols, Gary. Sedimentology and Stratigraphy, Wiley – Blackwell, Second edition, 2012.
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18. Shrock,R.R and Twenhofel,W.H. 1987. Principles of Invertebrate Paleontology McGraw Hill, New York.
19. Soman K, Geology of Kerala, Geological society of India, Bangalore, 2004.
20. Stanley, S.M., Earth and life through time, W.H. Freeman and company, 1986.
21. Tiwari, S.K., A text book of stratigraphy, micropalaeontology and palaeobotany, Kalyanipublishers, New Delhi, 2004.
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24. Weller, J.M. Stratigraphic Principles and Practice, Harper and Row, 1959.
25. Windley, B.F. The Evolving Continents, I Edition, John Wiley, 1977.
26. Woods, H., “Paleontology Invertebrate”, CBS Publications 1963

| Course Code | Course Name | Credits |
|-------------|---|---------|
| GE M 22 C09 | Analytical Geochemical Techniques and Instrumentation | 3 |

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| UNIT I |
| <p>Gravimetric methods Mechanism of formation of precipitates, Characteristics of ideal precipitate, Methods to improve filterability and minimizing adsorbed impurities.</p> <p>Precipitation from homogeneous solutions, Organic and inorganic precipitating agents.</p> <p>Applications of gravimetric methods</p> |
| UNIT II |
| <p>Volumetric methods Molarity, Normality, Standard solutions, End point. Acid-base titrations – titration curves, theory of indicators, Complexometric titrations-EDTA titrations-applications, Iodometry, Iodimetry, Colorimetric titrations</p> |
| UNIT III |
| <p>Spectrochemical methods Electromagnetic spectrum, Interaction of light with matter/molecule. Fundamentals of molecular spectroscopy. Wavelength selectors: Filters and Monochromators, Radiation detectors and Transducers, Mass spectrometry Atomic Absorption spectroscopy (AAS), Inductively coupled plasma mass spectrometry (ICP-MS) -principle and applications Microwave, IR, Electronic, Raman, NMR and ESR spectroscopy-principle</p> |
| UNIT IV |
| <p>Radiation detectors Dosimetry, Geiger Muller Counter, Scintillation Counter Electrochemical Methods: pH meter- Glass and reference electrodes, Conductivity method</p> |
| UNIT V |
| <p>Chromatographic Techniques and applications Paper Chromatography, Thin Layer Chromatography, Column Chromatography, Ion Chromatography, Gas Chromatography(GC), GC-MS, Liquid Chromatography, High Performance Liquid Chromatography (HPLC), LC-MS, LC-MS/MS</p> |

References

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3. Skoog, D.A. and Leary, J.J. (1992), Principles of Instrumental Analysis, 4th edition, Saunders's College Publishing, Fort Worth
4. Suchla, G (Ed.) (1987) Vogel's Qualitative Inorganic Chemistry, ELBS.
5. Willard, H.H., Merrit, L.L., Deen, J.A. and Settle, F.A. (1986), Instrumental Methods of Analysis, (Indian Reprint), CBS Publishers and Distributors, New Delhi
6. Skoog, West, Holler Crouch, Fundamentals of Analytical Chemistry, 8th edition, Cengage Learning J.Throck Watson, Introduction to Mass Spectrometry, 3rd edition, Lippincott-Raven publishers, Philadelphia, New York
7. Gary D. Christian. Analytical Chemistry, 5th edition, John Wiley and Sons

| Course Code | Course Name | Credits |
|-------------|--------------------------|---------|
| GE M 22 C10 | Geospatial Data Analysis | 3 |

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| UNIT I |
| GIS: Understanding base map (Toposheet, Geology map, cadastral map etc.) Understanding various Software's in GIS (ArcGIS, QGIS), Georeferencing base map |
| UNIT II |
| Creation of Spatial and Non spatial data (Geodatabase, Shapefiles, Attribute data), Creating and editing of Point, Line and Polygon |
| UNIT III |
| Vector data analysis (Explore, Report generations, Geometry calculations, SQL (Arithmetic and Boolean Operators), Overlay analysis (Clip, Erase, Split, Union, Identity, Intersect), Creation of Triangular Irregular Network (TIN) |
| UNIT IV |
| Remote Sensing: Accessing satellite images from various web portals (Earth Explorer, Bhuvan etc), Understanding various Satellite Missions and Sensors, Various Resolutions of Remote Sensing Data. Adding various bands of data to Image Processing Software, Understanding various resolution data, Dn values of Pixels, Layer Stacking, Preparation of Various Color Composites (True Color Composite, False Color Composite). |
| UNIT V |
| Introduction to Google Earth and Exploring various Tools Navigating, Finding Places, Marking Place using Layers, |

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| Map Features and introduction to KML files. Measuring distances and areas, Drawing Paths and Polygons, Importing data into Google Earth and KML file creation Using Image Overlays and 3D Models |
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| Course Code | Course Name | Credits |
|-------------|---|---------|
| AG M 22 C12 | Lab Course: II (Petrology & Geochemistry) | 3 |

IGNEOUS PETROLOGY

Megascopic and microscopic study of the following rocks with special stress to genetic significance: granite, syenite, diorite, pegmatite, aplite, lamprophyre, gabbro, dolerite, basalt, dunite, peridotite, pyroxenite, anorthosite and kimberlite.

Petrochemical Calculations: CIPW Norm and related calculations- 15 exercises. Use of IUGS triangular diagrams for classification of igneous rocks- 15 Nos.

Problem of application of Lever rule– 10 nos.

METAMORPHIC PETROLOGY

Megascopic and microscopic identification of the following rocks with special references to genetic significance of their mineralogy, textures/structures: slate, phyllite, schist, charnockite, khondalite, gneiss, pyroxene granulite, amphibolite, marble, quartzites and leptynite.

Graphical representation of metamorphic mineral paragenesis using ACF and AKF diagrams of the following facies -1 each. Greenschist, Amphibolite, Granulite, Eclogite, Albite-Epidote- Hornfels, hornblende-hornfels, Pyroxene-hornfels and Sanidinite facies. Simple thermobarometric calculations.

SEDIMENTOLOGY

Textural analysis of sediments: Sieve analysis, settling analysis, Size analysis. Size measurement and calculation of Shape parameters, plotting and interpretation of such data. Preparation of grain mounts -10 numbers. Study of grain mounts of magnetite, ilmenite, monazite, garnet, sillimanite, quartz, zircon, leucosene and chromite. Heavy mineral separation. Megascopic and microscopic study of limestone, sandstone, shale, conglomerate, breccia, clay, laterite, grit and arkoses.

GEOCHEMISTRY

Measurement of physico-chemical parameters: Eh, PH, turbidity, conductivity,

salinity, alkalinity. Chemical analysis of rocks and sediments: Preparation of solution A and B Estimation of major, minor and trace elements, Organic matter and carbonate

Water quality: Analysis of COD, Sulphate, Sulphide, Potassium, Iron, Total and dissolved metals in water

| Course Code | Course Name | Credits |
|-------------|--------------------------|---------|
| GE M 22 E04 | Geological Field Mapping | 2 |

Two weeks training for geological field mapping of igneous, metamorphic and sedimentary terrains. Training will be given for identification of minerals rocks and geological structures in the field and various sampling techniques employed in different terrains.

| Course Code | Course Name | Credits |
|-------------|---------------------------------|---------|
| GE M 22 E05 | Concepts of Disaster Management | 2 |

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| UNIT I |
| Science and Facts of Natural Hazards. Earth's processes as disasters: Internal and external. Causal factors and characteristics of disasters, Climate change and Disasters |
| UNIT II |
| Types and Classification of Disasters Natural Disasters: Meteorological disasters, Geological disasters, Biological disasters. Anthropogenic Disasters: Chemical, Industrial and Nuclear related Disasters, Accident related Disasters |
| UNIT III |
| Disaster Management Concepts Introduction to key concepts, terminologies and their complexities (Hazard, vulnerability, Exposure, Risk, Crisis, emergencies, Vulnerability, Disasters, Resilience) Disaster management Spectrum and its components, Disaster Management Cycle |

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| UNIT IV |
| International Disaster management System Organizations, bodies and Finance. International Strategies and functions. Role of United Nations in Disaster management. International Disaster management support system. Unified response strategy. Mapping Disasters using global datasets. National and international information networks and inventories |
| UNIT V |
| Disaster Management in Indian Context Major Disasters in India. National Vulnerability profile, National Disaster management Hierarchy and Institutionalization, National Disaster Decision support system. Technological applications. Role of research organisations. Challenges of disasters in India |

References

1. Coppola D. P., 2007. Introduction to International Disaster Management. Elsevier Butterworth-Heinemann
2. Peduzzi P., Dao H., and Herold C., 2005. Mapping Disastrous Natural Hazards Using Global Datasets Natural Hazards Volume 35, Number 2, 265-289,
3. Shaw R and Krishnamurthy R.R., (ed.) 2009. Disaster management Global Challenges and Local solutions. University Press, India
4. Keller E.D., and Blodgett R. H, 2006. Natural Hazards. Pearson Printice Hall
5. Kapur A., Neeti, Meena, Deepthima, Roshani and Debanjali, Disasters in India Studies of Grim Reality. Rawat Publications, New Delhi

SEMESTER – III

| Course Code | Course Name | Credits |
|-------------|------------------------------------|---------|
| GE M 22 C12 | Exploration Geology and Geophysics | 4 |

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| UNIT I |
| Principles of geological prospecting and mineral exploration. Resource and reserve – McKelvey and UNFC classification. Stages of exploration: Reconnaissance & Prospecting - General, Detailed, and Mine Exploration. Criteria for exploration - guides to ores. |
| UNIT II |
| Collection of exploration data and sampling techniques – Pitting, trenching and underground workings. Rock sampling methods – channel sampling, chip sampling, bulk sampling and bore hole sampling. Drilling - Design of drilling programme, types of drilling – coring and non- coring, vertical and inclined drilling. Borehole logging, ore reserve estimation, geostatistical method - concept, and conventional method. |
| UNIT III |
| Principles of Geochemical exploration, Geochemical cycle, geochemical mobility of element, factors controlling mobility of elements in the surficial and deep seated environments, Indicators and Pathfinders, threshold values and geochemical anomalies, dispersion pattern. Geochemical survey and sampling – lithological & pedological. Atmospheric and hydrogeochemical surveys, Geobotanical survey techniques, Biogeochemical survey. |
| UNIT IV |
| Concept of geophysical exploration. Electrical prospecting, Resistivity survey, Vertical Electrical Sounding (VES) and Constant Separation Traversing (CST). Fundamental types of electrode spreading – Wenner, Schlumberger and Dipole-Dipole configurations, apparent resistivity curves. Induced Polarization and Self Potential methods. |
| UNIT V |
| Concept of magnetic prospecting, Concept of Gravity survey, Concept of seismic survey. Radiometric methods - basic concepts of radioactivity and radioactive particles, radioactive rocks and minerals, instruments used in detection and measurements of radiation. |

References

1. Bagchi, T.C. Elements of Prospecting and Exploration, Kalyan Publishers.

2. Crompton, R.R. Manual of Field Geology, John Wiley.
3. Dobrin, M.B. Introduction to Geophysical Prospecting, Pergamon Press.
4. Davis and Dewiest. Hydrogeology, 1966.
5. Ginzburg, I.I. Principles of geochemical Prospecting, Pergamon Press.
6. Griffiths, D.H. and Kind, R.F Applied Geophysics for Geologists and engineers, Pergamon Press.
7. Kearey, P Brooks (1991) An introduction to geophysical exploration, Blackwell. Kovalarkim. Biochemical Hill.
8. Lahee, F.H. Field Geology, McGraw Hill.
9. Low, J.W Geologic Field Methods, Harper and Brothers.
10. Malyuga, D.P. Biochemical Methods of Prospecting, Consultants Bureau, New York.
11. Milson J (1989) Field geophysics, John Wiley & sons
12. Moon, Charles, Michel Whateley and Antony Evans (2005), Introduction to Mineral Exploration, Wiley – Blackwell.
13. Rose, K.W., Hawkes, H.E. and Webb, J.S., Geochemistry in Mineral Exploration, Academic Press.
14. Sinha, R.K. and Sharma, N.L. Mineral economies, Oxford and IBH Publishers.
15. William Lowrie, Fundamentals of Geophysics, Cambridge University Press, 1997.

| Course Code | Course Name | Credits |
|-------------|---|---------|
| GE M 22 C13 | Ore Geology and Indian Mineral Deposits | 4 |

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| UNIT I |
| Introduction to Mineral deposits. Morphology of ore bodies. Genetic classification of ore deposits. Physico- chemical environment of ore formation source, migration and traps in ore formation. Texture of ores and ore paragenesis. |
| Magmatic deposits in ultramafic rocks- chromite - podiform and stratiform, diamonds in Kimberlites, PGE deposits; Deposits associated with mafic rocks- Cu-Ni-Fe sulphide deposits; Deposits associated with felsic rocks - REE deposits. Pegmatitic deposits |
| UNIT II |
| Hydrothermal deposits- types, formation and properties of hydrothermal fluids, conditions favoring hydrothermal deposit formation- P-T-X condition and tectonic |

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| <p>environment.</p> <p>Magmatic hydrothermal deposits- Prophyry, Greisen, Skarn deposits. Seawater hydrothermal deposits- VHMS, Sedex, MVT. Other types- Unconformity-type U, Epithermal Ag-Au, lode Au deposits</p> <p>Sedimentary deposits- Syn sedimentary- QPC type U, phosphatic nodules, nodular Fe-Mn. BIF.</p> <p>Deposits formed by mechanical concentration- Placer deposits and types. Deposits formed by residual concentration- Bauxite and laterite; Infiltration- sandstone-type U; Supergene enrichment- Gossan.</p> |
| UNIT III |
| <p>Metamorphic deposits- Graphite and Aluminium refractory minerals. Metamorphosed deposits- Gondite. Non-metallic deposits – Asbestos, Talc, Clay and Tourmaline.</p> <p>Global metallogenic epochs and provinces with special references to Witwatersrand and Bushveld. Major metallogenic episodes in India. Mineralisation at plate boundaries.</p> |
| UNIT IV |
| <p>Mining terminologies: Methods of mining – Open cast-Manual and Mechanised, Glory hole, Underground – Gophering, Breast stoping, Open Underhand stoping, Open Overhand stoping, Pillar and Chamber and Alluvial mining - Sluicing, Hydraulic, Drift mining, Dredging, Derrick and Cableway. Shaft sinking – Mine support and ventilation.</p> |
| UNIT V |
| <p>Principles of mineral dressing. Types and uses of Crushers, Grinding mills, Screens and Classifiers. Physical methods of separation by grain size, gravity and magnetism. Chemical methods – reagents and their functions. Flotation. Flowsheets and its importance. Plans to be prepared and maintained in a mine – EMP, Mining plan, Mine closure plan, Surface plan etc. Mining legislation in India – National Mineral Policy. Mining hazards. Mining and environment.</p> |

References

1. Arogyaswamy, R.N.P. Courses in mining geology, Oxford and IBH pub. Co.
2. Asoke Mukherjee, 1970, Metamorphic and Metamorphosed Sulphide Deposits, Econ.Geol., Vol. 656, No. 70.
3. Asoke Mukherjee, 1988, Ore Genesis – A Holistic Approach, Prentice Hall, Calcutta.
4. Barry A. Wills, Tim Napier-Munn. Mineral Processing Technology, An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery, Elsevier Science & Technology Books
5. Brown, J. C. and Dey, A. K., 1936, India's Mineral Wealth, Oxford.
6. Edwards, A. B., 1960, Textures of the Ore Minerals, Aust. Inst. of Minerals and

Metals.

7. Evans, A. M., 1980, An introduction to Ore Geology, Blackwell Scientific Publication.
8. F.P.Shepard. Submarine geology, Harper International.
9. Gaudin, A. M, 1938, Principles of Mineral Dressing, Mc Graw Hill.
10. Howard L Hartman,Jan M.Mutmansky, Introductory Mining Engineering, John Wiley andSons Inc 2002.
11. Jensen M. L. and Bateman, A. M., 1962, Economic Mineral Deposits, Wiley.
12. Kraukoff K. B., Introduction to Geochemistry, Mc Grew Hill.
13. Kula C Misra, Understanding mineral deposits, Kluver Academic Publishers.
14. Park, C. G. and Mac Diarmid, R. A., 1964, Ore deposits, Freeman.
15. Petters, W.C. Exploration and Mining Geology. John Wiley.
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17. R.M Umathy, Text book of Mining geology, Dattsons 2002.
18. Reedman, JH Techniques in Mineral Exploration, Allied Scientific Publishers.
19. Robb, L., 2005, Introduction to Ore forming process, Blackwell Science Ltd, UK.
20. Roger Taylor, 2009, Ore textures, Recognition and Interpretation, Springer DordrechtHeidelberg, London.
21. Stanton R. L., Ore Petrology, Mc Grew & Hill
22. Taggart, A.P. Handbook of Mineral Dressing, Willey.
23. Wadia D. N., 1994, Minerals of India, National Book Trust, India, 5th edition.

| Course Code | Course Name | Credits |
|--------------------|-----------------------------------|----------------|
| GE M 22 C14 | Coal and Petroleum Geology | 3 |

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| UNIT I |
| Definition, origin, rank, and types of coal. Classification: Indian and International. Physical and petrographic characters: concept of Litho types, microlitho types, and macerals. Chemical characterization: proximate and ultimate analyses. |
| UNIT II |
| Application of coal petrology in solving geological problems and in hydrocarbon exploration. Sedimentology of coal bearing strata, coal forming epochs in geological |

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| past, coal deposits of India and their distribution. Methods of Coal prospecting and estimation of its reserves. Coal bed Methane: generation and exploration of coal as reservoir of methane. |
| UNIT III |
| Nature of petroleum: chemical composition and physical properties of organic matters and hydrocarbon. Origin of petroleum: organic and inorganic theories. Transformation of organic matter into Kerogen, organic maturation, thermal cracking of kerogen. Diagenesis, ketagenesis and metagenesis. Formation of petroleum in relation to geological processes: temperature, time, and pressure. Timing of oil and gas generation |
| UNIT IV |
| Migration of oil and gas: evidence of migration, primary and secondary migration. reservoirs – porosity, permeability and capillary pressure, porosity types in clastic and carbonate reservoirs, reservoir heterogeneity, drive mechanisms. Trapping mechanism for oil and gas, characteristic of structural, stratigraphic and combination traps. |
| UNIT V |
| Petroleum exploration- surface indication of oil and gas, sequence of exploratory steps. Formation evaluation: well-logging, types of well logs, interpretation of lithology, quality and quantity of formation fluids from well logs. Geology of productive oil and gas fields of India. |

References

- 1 Chandra, D., Singh, R.M. and Singh, M.P., 2000: Textbook of Coal (Indian Context)-Tara Book Agency, Varanasi.
- 2 Chapman R.E, Petroleum Geology, Elseiver Science Publishing company Inc. New York,1983
- 3 Holson, G.D. and Tiratsoo, E.N., 1985: Introduction to Petroleum Geology-Gulf Publ. Houston, Texas
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- 5 Jon Gluyas & Richard Swarbrick, Petroleum Geoscience, Blackwell Science publishing Ltd UK 2004.
- 6 Knut Bjorlykke, Petroleum Geoscience- From Sedimentary to Rock Physics, Springer Heidelberg Dordrecht, London, New York 2010.
- 7 Leverson, A.L. 1970. Geology of Petroleum. Freeman and co.,
- 8 North, F.K. Petroleum Geology, Allen & Unwin, London, 1985.
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- 10 Selley, R. C. 1998. Elements of Petroleum Geology, II Edition. Academic Press,
- 11 Singh, M.P., (Ed.), 1998: Coal and Organic Petrology-Hindustan Publ. Corp., New Delhi

- 12 Stach, E., (eds.), 1975, Stach's Textbook of Coal Petrology, Gebruder Borntraeger, Berlin
- 13 Thomas, L., 2012, Coal Geology, Wiley India Pvt Ltd, Delhi.
- 14 Tissot, B.P. and Welte, D.H., 1984: Petroleum Formation and Occurrence-Springer Verlag

| Course Code | Course Name | Credits |
|-------------|---------------------|---------|
| GE M 22 C15 | Engineering Geology | 3 |

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| UNIT I |
| Role of Geology in Civil engineering. Engineering properties of rocks. Rock as construction and foundation material, road aggregate. Rock mass classification – general ideas of RMR, RQD and SMR. |
| UNIT II |
| Soils – Geological and Engineering classification. Geological considerations in the following engineering projects: Dams, reservoirs and tunnels, bridges and highway roads |
| UNIT III |
| Reservoir sedimentation: Causes and effects, desilting methods. Coastal erosion – Near shore dynamics, erosion mechanisms and long shore drift. Measures for controlling coastal erosion – sea walls, groins and harbours. |
| UNIT IV |
| Seismicity as related to civil engineering construction, Seismic zone, Reservoir related earthquakes. Earthquake resistant structures. |
| UNIT V |
| Landslides: Role of Engineering Geology in mitigation and preventive measures for landslides |

References

1. Chenna Kesavulu, Text book of Engineering Geology, Macmillan India Ltd, Madras, 1993.
2. Donald P. Coduto, Geotechnical engineering principles and practices, Prentice Hall of India, Pvt. Ltd, New Delhi, 2001.

3. Krynine, D.P. and Judd, W.R. Principles of Engineering geology and Geotechnics, CBS Publishers and Distributors, New Delhi, 2001.
4. Robert B. Johnson and Jerome V. Degraff Principles of Engineering Geology, John Wiley and Sons 1976.
5. Gupta R. B. A Text book of Engineering Geology
6. Khusmi R. S. Fundamentals of Engineering Geology
7. Ramanathan R. M. Engineering Geology
8. Richy J.E. Elements of Engineering Geology
9. Parbin Singh. Engineering and General Geology
10. Trefethen Joseph M. Geology for Engineers.

| Course Code | Course Name | Credits |
|-------------|--------------|---------|
| GE M 22 C16 | Hydrogeology | 3 |

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| UNIT I |
| Hydrology and hydrogeology – Hydrological cycle. Geologic structures favoring groundwater occurrence and movement. Vertical distribution of groundwater. Groundwater reservoirs, Types of aquifers; springs and their types. Aquifer properties: Porosity, Permeability, Void Ratio, Specific Yield and Specific Retention – Aquifer parameters– Hydraulic conductivity, Transmissivity and Storativity. |
| UNIT II |
| Groundwater exploration- Subsurface investigations- test drilling, resistivity logging, SP logging, radiation logging- brief description. Groundwater movement – Water table and Piezometric level (surface) – Theory of groundwater flow – Darcy’s law and its experimental verification – differential equation governing groundwater flow. Hydrogeologic boundaries, flow nets, hydraulic conductivity and its determination in lab and field. Groundwater level fluctuations, global climatic change in relation to groundwater. |
| UNIT III |
| Well hydraulics: Aquifer tests, Organization and conduct of pumping tests, Pumping test data analysis and Recovery test, Drawdown and cone of depression– Steady radial flow to a well in confined and unconfined aquifers – Thiem’s equation and Dupuit-Forchheimer equation. Unsteady radial flow into wells in confined and unconfined aquifers – Theis equation – Theis, Chow and Cooper-Jacob methods – Isotropic non-leaky artesian aquifer. |
| UNIT IV |
| Well design criteria. Water wells– types of wells. Methods for drilling deep wells, Well |

production, specific capacity of pumps and specification of pumps. Quality of groundwater: Chemical characteristics of groundwater – Graphical representation of water quality data:– Interpretation of hydrochemical analysis data: Hill-Piper Trilinear diagram, Durov’s diagram and U. S. Salinity diagram – Sodium Adsorption Ratio (SAR) – Water quality standard: Domestic Water Criteria, Irrigation Water Criteria and Industrial Water Criteria– a brief idea.

UNIT V

Saline water intrusion in coastal and other aquifers and its prevention. Ghyben-Herzberg relationship– methods and need for artificial recharge to aquifers. Groundwater management: consumptive use, conjunctive use. Groundwater development– safe yield and optimal mining policy. Groundwater provinces of India. Groundwater conditions in Kerala.

References

1. Bouwer, H. Groundwater Hydrology, 1978.
2. Davis, S.N. and Dewiest, R.J.N. Hydrogeology, John Wiley and Sons Inc. New York, 1966.
3. Hiscock K (2005) Hydrogeology, Principle & Practice, Blackwell publishing.
4. Krisch R (2006) Groundwater geophysics, Springer - Verlag
5. Linsley, R. K., Kohler, M. A. and Taulhus, J. L. H. Applied Hydrology, Tata Mc GrawHill, 1975.
6. Reghunath, H.M. Groundwater. 2nd Edn. Wiley Eastern Limited. 1992.
7. Sharma H.S. Well Hydraulics and Tube Wells.
8. Todd, D. K. Groundwater Hydrology, John Wiley and Sons, 1980.
9. Walton, W. C. Groundwater Resource Evaluation, Mc Graw Hill Inc., 1970.

| Course Code | Course Name | Credits |
|-------------|--|---------|
| GE M 22 C17 | Lab Course III (Practical applications of geoinformatics in Geosciences) | 3 |

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| UNIT I |
| GIS: Rater Analysis in GIS, Creation of Digital Elevation Model Various Global DEMs (SRTM, ASTER, ALOS, CARTO) Creation of Slope, Aspect, Curvature, Viewshed etc) |
| UNIT II |
| Raster Analysis Tools Raster reclassification, Assigning Rank, Raster Overlay |
| UNIT III |
| Familiarization of Hydrology Tools: Flow Direction, Flow Accumulation, Stream Link, Stream Order, Watershed Extraction |
| UNIT IV |
| Weighted Overlay, Frequency Ratio Method, Fuzzy Logic Method |
| UNIT V |
| Remote Sensing : Digital Image Classification Supervised and Unsupervised Classification Image Enhancement Techniques (Spatial, Spectral and Radiometric) |
