Department of Geology

RAVENSHAW UNIVERSITY

CUTTACK

Syllabus for M.Sc. Applied Geology

2021

M.Sc. APPLIED GEOLOGY 2021

Semester I				
Paper No	**Paper code**	**Paper**	**Marks**	**Credits**
I	MG 1.1	General Geology and Tectonics	50	4
II	MG 1.2	Applied Mineralogy	50	4
III	MG 1.3	Structural Geology	50	4
IV	MG 1.4	Sedimentary Petrology	50	4
V **(Lab.)**	MG 1.5	Mineralogy, Structural Geology and Sedimentary Petrology	100	8
Semester II				
VI	MG 2.6	Igneous Petrology	50	4
VII	MG 2.7	Metamorphic Petrology	50	4
VIII	MG 2.8	Remote Sensing & GIS	50	4
IX	MG 2.9	Applied Geochemistry	50	4
X **(Lab.)**	MG 2.10	Petrology and Remote Sensing	100	8
Semester III				
XI	MG 3.11	Stratigraphy and Paleontology	50	4
XII	MG 3.12	Economic Geology	50	4
XIII	MG.3.13	Petroleum and Coal Geology	50	4
XIV	MG 3.14	Oceanography and Climatology	50	4
XV **(Lab.)**	MG.3.15	Stratigraphy and Paleontology	100	8
Semester IV				
XVI	MG.4.16	Ground Water Geology	50	4
XVII	MG 4.17	Engineering Geology, Environmental Geology and Disaster Management	50	4
XVIII	MG.4.18A	Geology of Ore Deposits	50	4
	MG 4.18B	Aerial Photography and Photogrammetry	50	4
XIX	MG 4.19A	Exploration and Mineral Engineering		
	MG 4.19B	Remote Sensing	50	4
XX	MG.4.20	Project and Seminar Presentation	100	8
			1200	96
VA	Water Quality Assessment			2
AO	Natural Hazards and Disaster Management			2

The Post Graduate Department of Geology offers two special papers and the students have to opt for any one of them (A or B).

A) Ore Geology (4.18) and Exploration and Mineral Engineering (4.19)

B) Aerial Photography and Photogrammetry (4.18) and Remote Sensing (4.19)

FIRST SEMESTER

MG1.1 General Geology and Tectonics 50Marks 4 Credits

Learning Objectives:

- Interaction of the atmosphere and the surface of the earth and the resultant landform development
- Understand the internal structure of the planet earth and the engine of internal dynamics
- Plate tectonics of active margins (oceanic ridges, rifts, transform faults, subduction zones, continental collision; obduction

Learning Outcomes:

The students will be able to

- By studying Physical geology students will be able to understand the nature of dynamic earth and the surficial manifestation of these forces
- The nature and development of the lithosphere and the movement of plates

Unit-I

Major geomorphic processes and associated landforms: tectonic, fluvial, Aeolian, coastal, karst and glacial. Geomorphic sub-divisions of India, Hill Slopes: Their characteristics and development, morphometric analysis of drainage basins, climatic geomorphology.

Unit-II

Weathering products, soils– formation, profiles, geological classification of soils, duricrusts, erosion, conservation, Beach Replenishment, Groins and Jetties, Sea Walls, Coastal Erosion.

Unit-III

Exploring the interior of Earth with seismic waves (Crust, Mantle, Core, Discontinuities), Plate Tectonics (The mosaic of plates, Rates of plate motion, The driving mechanism of plate tectonics; Types of plate boundary- convergent, divergent, Conservative), Continental drift (Geometric, Palaeontologic, Stratigraphic, Palaeomagnetic evidences)

Unit-IV

Theory of Isostasy, Geomagnetism and Paleomagnetism, Sea floor spreading, Mid-oceanic ridges, Island Arcs, Canyons and fans of the sea. Causes and formation of volcano, volcanic products, Types of volcanoes, volcanic topography, Causes of earthquake

Books:

1. Geomorphology – Savinder Sngh, CBS Publication
2. Principles of Geomorphology – W. D. Thornbury
3. Physical Geology – K. Siddharth
4. Global Plate Tectonics – Keary and Vine

MG 1.2 Applied Mineralogy 50Marks 4 Credits

Learning Objectives:

- Basics of crystal chemistry
- Understand the structure, chemistry, physical and optical character of various minerals.
- Learn the working principles of various instruments used for mineralogical analysis

Learning Outcomes:

The students will be able to

- By studying Physical and Optical mineralogy students will be able to identify the mineralogical composition of geological materials in order to help reveal their origin, evolution and end use.

Unit-I

Unit cells, Miller indices, Hermann-Mauguin symbol, zones and zone axis, ionic radii, coordination number, crystal irregularities, atomic substitution, Isomorphism, polymorphism and pseudo-morphism.
Silicate Minerals: study of structure, chemistry, physical and optical character of following mineral groups Olivine, Garnet, Pyroxene, Amphibole, Mica, Feldspar, Feldspathoid, spinel, Silica.

Unit-II

Polarized light, behavior of isotropic and anisotropic minerals under polarized light, refractive index, double refraction, birefringence, interference figure, 2V, pleochroic scheme, accessory plates

Unit-III

Need for mineral characterisation, Principles of Optical Microscopy, Electron Microscopy, EPMA, XRD, FTIR

Books :

1. Principles of Mineralogy – Dexter Perkins
2. Rutleys Elements of Mineralogy
3. Mineralogy – William D. Nesse
4. Optical Mineralogy – William D. Nesse
5. Optical Mineralogy – Dexter Perkins

MG 1.3 Structural Geology 50Marks 4 Credits

Learning Objectives:

- Understand Stress and strain, incremental deformation;
- Structural analysis in sedimentary, magmatic and metamorphic environments
- Ductile and brittle structures in rocks of various tectonic settings of the crust: causes and effects.
- Lithosphere rheology (brittle-ductile transitions);
- Analysis of continental deformation;

Learning Outcomes:

Upon successful completion of the course, students will have knowledge of

- Fundamental tools of structural analysis for the recognition of ancient and recent tectonic structures, developed at different structural levels and for identifying their deformational environment
- Kinematic criteria for the analysis of structures developed at different crustal levels under different thermal regimes

Unit-I

Rock deformation, Introduction, attitude of beds; V's rule; Deformation, concept of stress and strain; relation between stress and strain, Strain ellipses of different types and their geological significances. Effects of topography on structural features, Topographic and structural maps; Importance of representative factors of the map. Outlier, Inliers, Nappe, Klippe and Window.

Unit-II

Folds Fold morphology; Geometric and genetic classification of folds; Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding; recognition in field and map, causes of folding. Top and bottom criteria of deformed strata.

Unit-III

Faults and joints, Fault- classification, mechanism, significance, recognition in the field and map, general effects of faulting on outcrops. Joints - geometry, classification and significance.

Unit-IV

Unconformity - types, significance, recognition in the field and map, difference between fault and unconformity. Foliation - types and relation with major structures, Lineation - types and relation with major structures; Salt domes and diapirs

Books :

1. Earth Structure – Hackon Fossen
2. Structural Geology – M. P. Billings
3. Structural Geology – D. K. Mukhopadhayay

MG 1.4 Sedimentary Petrology 50Marks 4 Credits

Learning Objectives:

The purpose of this course is to understand

- Structure and texture of sedimentary rocks, their chemical and physical transformations that lead to major changes in the original petrophysical (porosity and permeability) characteristics.
- Tectonics and sedimentation, Mechanical analysis of rocks, understand provenance, reconstruction of palaeo-environment and paleo-current analysis.

Learning outcomes:

The students can be able to

- Understand the significance of heavy minerals.
- Know about the concept and principles of sequence stratigraphy, Basin Stratigraphy.

Unit-I

Sediment transport and genesis, occurrence of sedimentary rocks, Texture & Structure of Sedimentary Rocks, Diagenesis, Heavy Minerals and their significance, Classification of sedimentary rocks, Sedimentary environment

Unit-II

Genetic classification of sandstones and limestone, petrography of shale, conglomerate and breccias

Unit-III

Tectonics and sedimentation, cyclicity of sediments, Mechanical analysis of rocks, Sedimentary facies, study of provenance, reconstruction of palaeo-environment and paleo-current analysis

Unit-IV

Concept and principles of sequence stratigraphy, Mechanism of sedimentary basin formation; Basin Stratigraphy, sedimentary basins of India

Books:

1. Sedimentary Structures – Gary Nicols
2. Introduction to sedimentology – S. Sengupta
3. Sedimentology – Siderholm
4. Sedimentary Rocks – F. J. Pettijohn
5. Applied Sedimentology – R. C. Selly
6. Sedimentary Structure – Collinson and Thompson

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MG 1.5 Mineralogy, Structural Geology and Sedimentary Petrology

100 Marks 8 Credits

To consolidate learning, the practical work includes exercises concerning:

- Mesoscopic analysis of tectonites, kinematic indicators and fabrics in various rock types
- Interpretation of structural maps and cognate geological implications; elaboration, plotting and analysis of structural data
- Exercises on plate kinematics and interpretation of tectonic maps.
- Recognize and characterize different sedimentary rocks from their petrography.
- Understand the optical characteristics of various minerals by microscopic lab activities.

SECOND SEMESTER

MG 2.6 Igneous Petrology 50Marks 4 Credits

Learning Objectives:

- This course starts with the chemistry and physics of melts and their behavior under varying temperature and pressure conditions, and goes on to discuss the different kinds of igneous rocks and rock suites that form under different tectonic conditions.
- Upon completion of this course the student will have a comprehensive understanding of the mechanisms which control the diversity of igneous rocks and their relationships with tectonic regimes and crystallization of Unicomponent and Bi-component Magma, mineralogical phase rule and its application.

Learning Outcomes:

- This course will help in the understanding of melt generation and crystallization mechanisms, diverse rock types and their relation with the tectonic settings.

Unit-I

Origin of magma in different geologic milieu, texture of igneous rocks, Bowen's Reaction Principle, Magmatic evolution and differentiation and assimilation, IUGS classification of igneousrocks

Unit-II

Petrography and petrogenesis of Granite, Pegmatite, Basalt, Andesite, Ultrabasics, Anorthosite, Alkaline rocks, Carbonatite, Kimberlite

Unit-III

Magmatism and tectonics: Inter-relation between tectonic setting and igneous rock suites,

Unit-IV

Crystallisation of Unicomponent and Bi-component Magma, Eutectic, Solid Solution (Ab-An Series), Incongruent Melting, Ternary Magma (Di-Ab-An,Di-Ab-An,An-Fo-Sio_2), mineralogical phase rule and its application

Books :

1. Introduction to Igneous and Metamorphic Geology – J. D. Winter
2. Introduction to Petrology – G. W. Tyrrel
3. Igneous and Metamorphic Petrology – M. G. Best

MG 2.7 Metamorphic Petrology 50Marks 4 Credits

Learning Objectives:

- The study of metamorphic rocks encompasses the chemical and physical transformations that take place in response to changing pressure, temperature, and chemical environments in the Earth's interior.
- In this course, different petrogenetic processes involving mineral reactions will be explored using equilibrium thermodynamics.
- The course provides idea about the ACF & AKF diagrams, Phase rule, paired metamorphic belts.

Learning Outcomes:

Having successfully completed this module students will be able to:

- Explain how textures of metamorphic rocks provide evidence of their origin.
- Identify the common rock forming minerals of metamorphic rocks in both hand specimen and thin-section and classify the rock.
- Describe the tectonic environments where you find each type of metamorphism, and features associated with metamorphism in these environments.

Unit-I

Types and agents of metamorphism, common minerals of metamorphic rocks, Metamorphic Zones, Grade and facies,

Unit-II

ACF& AKF diagrams, Phase Rule, Metasomatism, Metamorphic differentiation. Paired metamorphic belt

Unit-III

Prograde and retrograde metamorphism, Regional and contact metamorphism of pelites, arenites, carbonates and igneous rocks.

Unit-IV

Petrogenetic aspects of various rock suites of India like Gneisses, Schist, Quartzite, Slate, Marble, Khondalite, & Charnockite, Migmatites

Books:

.1. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
2. Winter,J.D.(2014).Principles of igneous and metamorphic petrology. Pearson.
3. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.

4. Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
5. Hota,R.N.(2017) Practical approach to petrology, CBS Publishers and Distributors, New Delhi
6. Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Earth Science Series

MG 2.8 Remote Sensing and GIS 50Marks 4 Credits

Learning Objectives:

Students will be able to:

- Explain the principles of remote sensing and its application.
- Develop capabilities of understanding and interpreting remote sensing data. Acquire knowledge and critical thinking skills to solve a real-world problem with appropriate remote sensing data and processing methods.
- Critically assess the strengths and weaknesses of remote sensing instruments and platforms for a variety of application scenarios.
- Critically evaluate the opportunities and available methods for integrating remote sensing and GIS.

Learning Outcomes:

- This course provides fundamental understanding and working knowledge of the principles and applications of remote sensing and GIS that is fundamental to understanding the Earth system.
- Use of aerial photographs for the production of geological maps.
- The principles of the Remote sensing satellites in operation: LANDSAT, SPOT, IRS, also their sensor characteristics and application.
- The remote sensing over the last decades has been applied in the fields of geology, mineral exploration, forestry, agriculture, hydrogeology, soils, land use, etc. - that is, in all pursuits of sciences dealing with the features, processes, and phenomena operating at the earth´s surface.

Unit-I

Energy sources and radiation principles, Energy interaction in the atmosphere, Energy interactions with earth surface features, an ideal remote sensing system, areal remote sensing system.

Unit-II

Types of platforms and sensors; resolution of sensors- spatial, spectral, radiometric and temporal. Remote sensing satellites in operation: LANDSAT, SPOT, IRS, their sensor characteristics and application.

Unit-III

Thermal radiation principles- radiant vs Kinetic temperature, Black body radiation, Interaction of thermal radiation with terrain elements, Fundamentals of microwave remote sensing, SLAR: system components, spatial resolution, Synthetic Aperture Radar (SAR).

Unit-IV

Objectives of Geographical Information Systems, components of GIS, conceptual models of spatial information- raster and vector data models, advantages and disadvantages of raster and vector data models, non-spatial information and concept of data base, data base structures-hierarchical, network and relational, important features of relational database structure- primary and foreign keys.

Books :

1. Introduction to Remote Sensing – R. P. Gupta
2. Remote Sensing and Image Interpretation – Lillesand
3. GPS theory and practice – Hoffman
4. Fundamentals of GIS – Demers
5. Introduction to Remote Sensing – Gibson
6. Principles of GIS – P. A. Burrough

MG 2.9 Applied Geochemistry 50Marks 4 Credits

Learning Objectives:

- The course aims to allow the student to use stable and radiogenic isotopes to track natural and anthropogenic processes in different earth reservoirs and describe how radiogenic isotope signatures can be used to trace the source of minerals, rocks and fluids.
- This course lays out the basic principles and techniques of modern geochemistry
- These basic concepts are applied to understanding the processes in aqueous systems and the behavior of trace elements in magmatic systems.
- To learn the working principles of various instruments used for geochemical analyses

Learning Outcomes:

The students will be able to

- Understand various geochemical and geobiological processes that are undergoing in the earth
- Explain the fractionation of stable isotopes and their application.
- Hands on experience in certain instruments will enhance the basic understanding of their operations

Unit-I

Properties of isotopes, Oxygen isotope, Sulphur isotope, Carbon isotope, Hydrogen isotope, Strontium Isotope, Rubidium-Strontium method, Uranium-Thorium-Lead Method, Potassium-Argon method, Radio carbon dating.

Unit-II

Cosmic abundance of elements, Primary geochemical differentiation of earth, Structure and Composition of Earth, Geochemistry of hydrosphere, biosphere and atmosphere, geochemical classifications of elements

Unit-III

Composition of the planets and meteorites, Trace elements and Rare Earth Elements and their importance in fractional crystallization during magmatic / partial melting, distribution of trace elements in rocks, Lunar rock, Geochemical cycle

Unit-IV

Classical methods of geochemical analysis, Principles of High precision analytical methods-XRF,AAS, ICP-MS, UV-Vis-Spectro-photometry, Flame-photometry

Books :

1. An introduction to Geochemistry – Alberede
2. Geochemistry – Berry and Mason
3. Essentials of Geochemistry -= J. V. Walther

MG 2.10 Petrology and Remote Sensing 100Marks 8 Credits

- Identify the common rock forming minerals of igneous and metamorphic rocks in both hand specimen and thin-section and classify the rock.
- Recognize and characterize different igneous and metamorphic rocks from their petrography.
- Study and identify the various natural features present in aerial photographs and satellite imageries.

THIRD SEMESTER

MG 3.11 Stratigraphy and Paleontology 50Marks 4 Credits

Learning Objectives:

Students will be able to:

- Understand the principles of the preservation of chronological information in the stratigraphic record, and the recovery of that information from the rock record.
- Understand a variety of correlation and dating methods.
- Invertebrate paleontology was once called the 'handmaiden of stratigraphy' because of the usefulness of fossils for correlating sedimentary strata.
- Thus, students will learn to identify and use fossils as geological tools, and learn how paleontologists analyze fossils to interpret the history of life on Earth.
- Understand the application of micropalaeontology and palynolgy in palaeoclimatic analysis and petroleum industries.

Learning Outcomes:

Upon successful completion of the course, students will be able to-

- Understand the Stratigraphic sequence of different geologic formations.

- Recognise their palaeontological records and their economic prospect.
- Gain knowledge about the groups of microfossils, how these groups can be helpful for fossil fuel exploration.
- Understand paleoclimatic, paleo oceanographic and paleogeographic variations through micropaleontology.

Unit-I

Principle of Stratigraphy, Stratigraphic correlation, Standard stratigraphic time scale and their Indian equivalence, Code of Stratigraphic Nomenclature, General character, Stratigraphy, structure, lithology and economic resources of Dharwar, Singhbhum, Cuddapah, Vindhyan.

Unit-II

General character, Stratigraphy, structure, lithology, economic resources and fossil contents Gondwana Supergroup, Triassic of Spiti, Jurassic of Kutch, Cretaceous of Trichinopoly. General character, Stratigraphy, structure, lithology, economic resources and fossil content of type areas of Tertiary of Assam, Siwalik and Deccan Trap,

Unit-III

Study of morphology, evolutionary trends, distribution and geological history of brachiopods, pelecypods, gastropods, cephalopods, echinoids and trilobites. Biodiversity and mass extinction events.

Unit-IV

Objectives of micro-paleontology, study of microfossil groups; Foraminifera, Ostracods, Coccolithophores and Diatoms. Applications and importance of diatoms, introduction to palynology.

Books :

1. Historical Geology – Ravindra Kumar
2. Stratigraphy of India – Radhakrishnan and Vaidyanathan
3. Stratigraphy and Sedimentology – Sam Boggs

MG 3.12 Economic Geology 50Marks 4 Credits

Learning Objectives:

Students will be able to:

- The basics of ore forming processes
- The occurrence and distribution of various metalliferous and non-metalic minerals

Learning Outcomes:

Upon successful completion of the course, students will be able to-

- To classify the economic mineral deposits
- To Understand the various controls that are operative during the formation of the deposits.

Unit-I

Ores and ore minerals, grade, tenor and specification. Classification of mineral deposit, control of ore localization- structural, stratigraphic, physical, chemical and lithological

Unit-II

Magmatic processes of mineralization, hydrothermal mineralization

Supergene sulphide enrichment, residual concentration, mechanical concentration deposit

Unit-III

Occurrence and distribution in India of metalliferous deposits of iron, manganese, bauxite, chromium

Unit-IV

Indian deposits of non-metals – Diamond, mica, gypsum, barites and beryl

Books

Evans, A.M. (1993) Ore Geology and Industrial Minerals, Blackwell
Stanton, R.L. (1972) Ore Petrology, McGraw Hill
Barnes, H.L.(1979) Geochemistry of Hydrothermal Ore Deposits, John Wiley
Klemm, D.D. and Schneider, H.J. (1977) Time and Strata Bound Ore Deposits. Springer Verlag
Cuilbert, J.M. and Park, Jr. C.F. (1986) The Geology of Ore Deposits. Freeman
Mookherjee, A. (2000) Ore Genesis – A Holistic Approach. Allied Publisher
Wolf, K.H. (1976-1981) Hand Book of Stratabound and Stratiform Ore Deposits. Elsevier
Ramdohr, P. (1969) The Ore Minerals and their Intergrowths. Pergamon Press

MG 3.13 Petroleum, Coal and Nuclear Geology **50 Marks** **4 Credits**

Learning Objectives:

Students will be able to:

- Learn about coal forming processes, classification, and analysis
- Gather knowledge of Indian coal deposits
- Learn about the geological processes involved in hydrocarbon deposits.
- Knowledge on Indian petroleum basins and techniques practiced in the petroleum industry.

Learning Outcomes:

Upon completion of the course, students will be able to:

- Understand the chemical and physical properties of hydrocarbons.

- Identify the Hydrocarbon basins in India.
- Understand the role of microfossils in hydrocarbon exploration.
- Distinguish between different types of coal based on physical, chemical and petrographical and other properties.
- Role of Coal Geology in industrial development

Unit-I

Definition, Formation of coal, varieties of coal, Origin and Indian distribution of coal, Stratigraphy of coal measures Rank of coal, Coal Analysis; Proximate analysis, Ultimate analysis, Microscopic constituents of coal, Coal carbonization, Hydrogenation, Liquification and gasification, underground coal gasification, Coal bed Methane,

Unit-II

Origin, migration and entrapment of natural hydrocarbons, Mode of occurrence of petroleum, seepages, mud volcanoes, oil shale or kerogen shale, structural, stratigraphic and mixed traps;

Unit-III

Reservoir rocks, pore space, classification and origin of pore space, reservoir fluids; water, oil and gas; Reservoir Pressure: Measurement of pressure, sources of pressure, anomalous pressure, capillary pressure, Reservoir temperature; measurement of temperature, sources and effects of heat, Interface phenomenon, reservoir energy. Methods of Petroleum Exploration

Unit-IV

Nuclear fuel cycle, mineralogy and geochemistry of radioactive minerals, classification of uranium deposits. Metallogenic epochs and provinces of uranium mineralization.

Books :

Chandra, D., Singh, R.M. Singh, M.P., 2000: Textbook of Coal (Indian context). Tara Book Agency, Varanasi.
Stach;, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichumullelr, M. and Teichmuller R., 1982: Stach Texbook of Coal petrology. Gebruder Borntraeger, Stuttgart.
Selley, R.C., 1998: Elements of Petroleum Geology. Academic press.
Boyle, R.W., 1982: Geochemical prospecting for Thorium and Uranium deposits, Elsevier.
Holson, G.D. and Tiratso, E.N., 1985: Introduction to Petroleum Geology. Gulf Publishing, Houston, Texas.
Singh, M.P. (Ed.) 1998: Coal and organic Petrology. Hindustan Publishing Corporation, New Delhi.
Tissot, B.P. and Welte, D.H., 1984: Petroleum Formation and Occurrence, Springer – Verlalg.
Durrance, E.M. 1986: Radioactivity in Geology-principles and application. Ellis Hoorwool.

MG 3.14 Climatology and Oceanography 50Marks 4 Credits

Learning Objectives:

- The course focuses on providing students with an understanding of the components of the climate system, climate system dynamics, and factors that lead to changes in the climate system.
- Students will be able to understand the role of the land surface in climate forcing (surface fluxes and the hydrologic cycle), global atmospheric and oceanic circulation, climate variability and its role in weather forecasting (ENSO, the NAO, and monsoons), and long-term climate forcing.
- The course describes how wind patterns, the rotation of the Earth, and continents affect surface currents in the ocean.

Learning Outcomes:

After studying this course, students will be able to:

- Explain (both analytically and qualitatively) how the climatologically averaged ocean and atmospheric circulation patterns redistribute heat and energy across the Earth.
- Be able to use climatology and their understanding of global indices (ENSO, NAO) to assist them in weather forecasting.
- Students will be able to understand how ocean currents work and understand biological productivity in the oceans.

Unit-I

Introduction to climatic geology, atmosphere, lithosphere and ocean dynamics, Antarctica and study of ice sheets, global warming atmospheric aerosols and air pollution, framework of climate change, Milankovitch cycles and solar activity

Unit-II

Thermal Structure & Composition of Atmosphere; Elements of Climate and weather; Jet stream and its influence on world weather; Air Mass, their classification and influence on world weather; Fronts (Front classification). Coupled ocean-atmosphere system, El Nino Southern Oscillation (ENSO). General weather systems of India, - Monsoon system, Western disturbances and severe local convective systems

Unit-III

Relief of ocean floor (Continental Shelf, Continental Slope, Continental Rise and Abyssal Plain), Marine sediments and their classification (Lithogenous, Biogenous, Hydrogenous, Cosmogenous), Sea floor mineral resources, law of the sea

Unit-IV

Physical and chemical properties of sea water and their spatial variations. Residence times of elements in sea water. Ocean currents, waves and tides, important current systems, thermohaline circulation and the oceanic conveyor belt. Biological productivity in the oceans

Books :

Oceanography; A view of the Earth by M. Grant Gross. Prentice Hall, Year 1977
Oceanography, Savinder Singh, Pravalika Publication, Allahbad
Climatology, Dr. D. S. LAL, Sharda Pustak Bhavan, Prayagraj
Oceanography, Vatal Sharma
Essentials of Oceanography, Alan P. Trujillo and Harold V. Thurman
Oceanography and Climatology, K. Siddharth

FOURTH SEMESTER

MG 4.16 Groundwater Geology 50 Marks 4 Credits

Learning Objectives:

Students will be able to:

- Assess the role of water in Earth's climate
- Apply Darcy's Law to groundwater flow and geological material interpretation;
- Use pump test data for groundwater flow applications.
- Develop skills in approaching complex problems involving flow and storage of groundwater
- Gain knowledge on sustainable development of groundwater resources.

Learning Outcome:

- In this course the students will study the fundamental concepts and principles of occurrence, movement and quality of groundwater, focusing on quantitative analysis.

Unit-I

Rocks and water, hydrologic cycle, aquifers, porosity, specific yield and specific retention, heads and gradients, hydraulic conductivity and permeability. Ground water movement and topography; ground water velocity, transmissivity, storage co-efficient, cone of depression.

Unit-II

Aquifer test, analysis of aquifer test data- Time drawdown analysis, distance drawdown analysis, single well test, well interference, aquifer boundaries, test affected by lateral boundaries, test affected by leaky confining beds

Unit-III

Well construction methods; well logs, water well design, well efficiency, specific capacity and transmissivity, measurement of water level and pumping rates

Unit-IV

Quality of groundwater and quality criteria for different uses, Groundwater provinces of Orissa and India, saline water intrusion, Waste water reuse systems, Organic and inorganic contamination of groundwater and their remedial measures

Books :

Todd, D.K. (1988): Ground Water Hydrology, John Viley & Sons,New York.
Raghunath,H.M. (1983): Ground Water, Viley Eastern Ltd., Calcutta
Applied Hydrogeology , C. W. Fetter
Driscoll, F.G.(1988): Ground Water and Wells, UOP, Johnson Div. St. Paul. Min. USA
Davies, S.N. and Dc-West, R.J.N. (1966): Hydrogeology, John Willey & Sons, New York.
Ground Water and Wells (1977): UOP,Johnson, Div. St. Paul. Min. USA

MG 4.17 Engineering Geology, Environmental Geology and Disaster Management 50 Marks 4 Credits

.Learning Objectives:

Students will be able to:

- Classify various geological strata for their engineering use.
- Apply various techniques for development of various types of engineering structures.
- Determine expected loads and design and evaluate the capacity of support systems.

Learning Outcome:

- The student will gain knowledge for development of engineering, geological projects and geotechnical mitigation measures of natural hazards.
- The application of geological knowledge in planning, designing and construction of big civil engineering projects. Its knowledge is helpful for river control and shipping work. Its knowledge is helpful for construction of dams.

Unit-I

Engineering properties of rocks and soils and their classification, rock slope stability, landslides, construction materials, dams and reservoirs, major river valley project of India, tunnels and excavations, foundations and structures in earthquake prone areas, site investigations and important case studies.

Unit-II

Rock Mechanics: Concept, Mechanism and Significance of Rock Quality Designation (RQD) Concept, Mechanism and Significance of: Rock Structure Rating (RSR), Rock Mass Rating (RMR), Tunnelling Quality Index (Q)

Unit-III

Coal hazards and mitigation measures- Environmental impact of coal mining, acid mine drainage, mine subsidence, groundwater inundation, spontaneous combustion of coal, environmental impact of coal based power plants, disposal of coal ash, carbon sequestration, Disposal of industrial and radioactive waste, Mineral Conservation, Sustainable Mining

Unit-IV

Drought, Flood, Cyclone, Tornado, Thunderstorm, Earthquake, Land slide, Tsunami, Inundation of Coastlines- their management and mitigation strategies

Books :

1. Krynine, D.H. & Judd, W.R. (1998) Principles of Engineering Geology, CBS Edition.
2. Schultz, J.R. & Cleaves, A.B. (1951) Geology in Engineering, John Willey & Sons, New York.

SPECIAL PAPER I

MG 4.18 A Geology of Ore Deposits 50 Marks 4 Credits

Learning Objectives:

Students will be able to:

- Understand the different ores of diverse geological setting and terrains with implications for exploration.
- Identification of minerals based on their optical properties and textural behaviour and their application in mineral beneficiation industries.
- To know the source and depositional environment based on isotopic and fluid inclusion studies.

Learning Outcomes:

- The course deals with the natural mineral resources and their association with different host rocks during their formation. The fundamental concepts regarding the origin of the mineral can be well understood with a thorough knowledge on the mineral assemblages, textural features, paragenetic order and metallogeny.
- Learn about the geological processes that lead to the formation of mineral deposits in nature, and about which minerals and rocks represent important resources for society.

Unit-I

Mineral paragenesis, Metallogenic epochs and provinces. Wall-rock alteration, mineral zoning, geological thermometry and barometry, Rock-ore association.

Unit-II

Mineralisation associated with –ultramafic, mafic and acidic rocks, greenstone belts, komatiites, anorthosites and kimberlites and submarine volcanism. Fluid inclusion studies, porphyry, Greisen, and skarn deposit. Contact metasomatism, evaporates.

Unit-III

Occurrence and distribution in India of metalliferous deposits - base metals, gold and PGM. Indian deposits of non-metals –asbestos, graphite, kyanite, pyrophyllite

Unit-IV

Minerals used in refractory & abrasives industries; minerals used in glass, ceramic &cement industries and minerals used in fertilizer industries including phosphorite deposits.

Books:

Evans, A.M. (1993) Ore Geology and Industrial Minerals, Blackwell
Stanton, R.L. (1972) Ore Petrology, McGraw Hill
Barnes, H.L.(1979) Geochemistry of Hydrothermal Ore Deposits, John Wiley
Klemm, D.D. and Schneider, H.J. (1977) Time and Strata Bound Ore Deposits. Springer Verlag
Cuilbert, J.M. and Park, Jr. C.F. (1986) The Geology of Ore Deposits. Freeman
Mookherjee, A. (2000) Ore Genesis – A Holistic Approach. Allied Publisher
Wolf, K.H. (1976-1981) Hand Book of Strata bound and Stratiform Ore Deposits. Elsevier
Ramdohr, P. (1969) The Ore Minerals and their Intergrowths. Pergamon Press

MG 4.19 A Exploration and Mineral Engineering 50Marks 4 Credits

Learning Objectives:

Students will be able to:

- Understand the different approaches of mineral exploration using different tools.
- Can build up confidence in sampling and reserve estimation.
- Mineral economics of a deposit need to be discerned from different methodologies.

Learning Outcomes:

- The primary goal of the course is to introduce the fundamental aspects of exploration strategies.
- Different sampling methodologies and resource evaluation are basic ingredients of the course.

Unit-I

Prospecting and Mineral exploration using different techniques such as Geological,

Geochemical, Geo-botanical and Geophysical method- (Electrical, Magnetic, Gravity, Seismic and Radioactive methods).

Unit-II Sampling, salting, Quality Control, Different method of drilling and mining, mine development, mine machineries, fundamentals of blasting techniques

Unit-III

Methods of Ore reserve estimation, United Nations Framework Classification of Ore Reserve Estimation, and National Mineral Policy. Strategic, critical and essential minerals. Changing patterns of mineral consumption, Mineral Concession Rules, MMDR Act.

Unit-IV

Comminution, Crushing and operational features of Jaw crusher, Roll Crushers, Grinding -Ball Mill, Rod Mill, Size analysis. Different Techniques of beneficiation: Gravity Separation, Jigging, Dense Media Separation, Tabling, Froth floatation, Magnetic and Electrostatic Separation

BOOKS

P.K. Banerjee and S Ghosh (1997): Elements of prospecting for non-fuel mineral deposits
Bagchi, T.C., Sengupta, D.K., Rao, S.V.L.N. (1979): Elements of Prospecting and Exploration.
Sinha, R.K. and Sharma, N.L. (1976) Mineral Economics.
Arogyaswami, R.P.N. (1996) Courses in Mining Geology

SPECIAL PAPER II

MG 4.18 B AERIAL PHOTOGRAPHY AND PHOTOGRAMMETRY

50Marks 4 Credits

Learning objectives:

- To introduce the basic principles of photogrammetry and aerial photography to the students at their graduation level in order to make them acquainted in interpreting aerial photographs for practical purposes.

Learning outcomes:

- Since aerial photography has wide use in geological investigation, students will be benefited from learning about it at an early stage and will be able to apply their knowledge in the field of exploration.

Unit-I

Early history of aerial photography, Aerial platform, Photographic Imaging: Introduction, Digital Image, Camera systems, Filters, Films, Vantage point, Ideal time, Atmosphere for Aerial Remote sensing.

Unit-II

The simple camera, Basic negative to positive photographic sequence, Spectral sensitivity of black &white films, Colour film, Processing of colour films, colour infrared films, Filters & their signification in Remote sensing.

Unit-III

Aerial camera and types, Types of aerial photographs, Geometry of aerial photographs, Scale of aerial photographs, Taking of vertical aerial photographs, Ground coverage of aerial photographs, Area measurement, Photo mosaics, flight planning

Unit- IV

Introduction to photogrammetry, Development of photogrammetry, Photogrammetric process Orientation &Triangulation DTM/DEM generation, Ortho rectification, Contour map generation, Limitations of photogrammetry. Relief displacement, Stereoscopy as applied to aerial photography, Image parallax, Parallax measurement, Stereoscope, Ortho photos.

Books

1. Aerial photographs and photogeology – Shiv Narayan Pandey
2. Remote sensing and image interpretation-Jensen

MG 4.19 B REMOTE SENSING 50Marks 4 Credits

Learning Objectives:

Students will be able to:

- Develop capabilities of understanding and interpreting remote sensing data. Acquire knowledge and critical thinking skills to solve a real-world problem with appropriate remote sensing data and processing methods.
- Critically assess the strengths and weaknesses of remote sensing instruments and platforms for a variety of application scenarios.

Learning Outcomes:

- Student will be benefited by learning remote sensing to widen their knowledge in geosciences as it is a very good tool to extract information about land surface, composition or subsurface.
- The subject provides information on lithology on rock composition based on spectral reflectance. It has both direct and indirect geological application.

Unit-I

Concept and foundations of remote sensing: Basics of Remote sensing, Fundamental of Thermal Remote Sensing, Thermal infrared radiation properties. Atmospheric effect of thermal remote sensors, Interaction of thermal radiation with terrain element, Thermal scanners, Interpreting thermal scanner imagery, Geometric characteristics of thermal imagery, Temperature mapping with thermal scanner data.

Unit-II

Microwave Remote sensing: Fundamental of microwave remote sensing, SLAR: system components, spatial resolution, Synthetic Aperture Radar (SAR), Geometric characteristics of SLAR imagery, Earth surface features influencing radar returns, Interpretation of SLAR imagery. Microwave satellite in operation: Seasat, Radarsat, Shuttle, Imaging Radar (SIR) , ERS :Elements of Passive microwave remote sensing , Passive microwave scanner , application of passive microwave remote sensing

Unit-III

Hyper-spectral Remote Sensing Hyper spectral image analysis: Atmospheric correction, Analysis technique of hyper spectral remote sensing, Biophysical modeling, Image transmission & compression. Spectroscopy, Image cube, hyperian/HYSI, Spectral matching, Digital Spectral Data, Libraries, Application of Hyper spectral data, MODIS

Unit-IV

Fundamental of LIDAR remote sensing, LIDAR Data Processing, LIDAR Data Management and Applications, Terrestrial and Bathymetric Laser Scanner

Books

1. Geoinformation (Remote Sensing): Gottfried Konecny
2. Textbook of remote sensing & Geographical Information System: M. Anji Reddy
3. Remote sensing & Geographical Information System: Dr. Wasim Ahmed Zaidi
4. Advance in Remote sensing & GIS Analysis: Petter M. Atkinson & Nicholas J Tate

MG 4.20 Field Study, Project and Seminar Presentation

100Marks 8 Credits

This is a training related to geological mapping in structurally deformed metamorphosed terrains. This is another very important and fundamental requirement of the 2 years Applied Geology branch to train the students how to undertake field mapping. They learn how to take locations, measurements of Dip, Strike, Pitch and Plunges of planar and linear elements of a rock in tectonically deformed terrains to find the structural geometry of the area. During the course of this work they also study the ore minerals associated with the terrains. Upon completion of the course, students will be able to lay out their field observation, analytical methods and correlation results in their final presentation.

VALUE ADDED COURSE
2 CREDITS
COURSE DURATION – 30 HOURS
COURSE CODE-VA
WATER QUALITY ASSESSMENT

Course Objectives:

- Understand what is groundwater Quality
- To comprehend on approaches and measures of disaster management, preparedness and response and related policies, law and methods.

Course Outcomes:

- Upon successful completion of the course, students will be able to:
- Develop a sound understanding of disaster risk and related underlaying factors, their impacts.

UNIT-I

Introduction to Water Quality, why need for water quality, instrumentation for water quality analysis and their working principles- Ion Chromatograph, Spectrophotometer, Flame photometer, pH meter, TDS meter, ORP meter, Analysis of major ions, Estimation of pH using pH meter, Estimation of electrical conductivity using conductivity meter, Estimation of temperature using temperature meter, Estimation of total solids (TS), Suspended solids (SS)

UNIT-II

Estimation of calcium (Ca) by EDTA, Estimation of Magnesium (Mg) by volumetric titration method, Estimation of Total hardness by volumetric titration method, Estimation Bicarbonate and Carbonate by titration, Estimation of Chloride by volumetric titration method, Estimation of Sodium and Potassium by Flame photometer, Estimation of Sulphate by spectrometric method, Estimation of Nitrate by spectrometric method in UV-range and Visible range, Estimation of Fluoride by SPADNS spectrometric method

UNIT-III

Data validation, chemical equivalence, graphical representation of water quality, suitability of water in different fields use - Drinking water, Irrigation water, Quality of water used in industries, Groundwater exploration by resistivity meter.

ADD ON COURSE
2 CREDITS
COURSE DURATION – 30 HOURS
COURSE CODE-AO
NATURAL HAZARDS AND DISASTER MANAGEMENT

Course Objectives:

- The course objectives is to provide a systematic knowledge base on disaster typology, risk, vulnerability, their impacts
- To comprehend on approaches and measures of disaster management, preparedness and response and related policies, law and methods.

Course Outcomes:

- Upon successful completion of the course, students will be able to:
- Develop a sound understanding of disaster risk and related underlaying factors, their impacts.

Unit: I Introduction to Disaster Management

Hazards and Disasters, Risk and Vulnerability in Disasters, Natural disasters: earthquakes, floods, drought, landslide, cyclones, volcanoes, tsunami, global climate extremes.

Man-made disasters: CBRN – Chemical disasters, biological disasters, radiological disasters, nuclear disasters, Fire – building fire, coal fire, forest fire, Oil fire, Accidents- road accidents, rail accidents, air accidents, sea accidents, Pollution - air pollution, water pollution, Deforestation, Industrial waste.

Unit: II Study of Disasters

Earthquakes and its types, magnitude and intensity; seismic zones of India, Guidelines for Disaster resistant construction, earthquake resistant construction technique.

Case studies (Global & National) in disaster management & rehabilitation/re-settlement: Case Studies in Disaster Management in Odisha: 1999 Odisha super cyclone, Cyclone Phailin, Cyclone Hudhud, Floods in Odisha.

Unit: III Mitigation and Management techniques of Disaster

Basic principles of disasters management, Disaster Management cycle, Disaster management policy, National and State Bodies for Disaster Management, Early Warning Systems.