STATE MODEL SYLLABUS FOR UNDER GRADUATE COURSE IN GEOLOGY (Bachelor of Science Examination)

DEPARTMENT OF GEOLOGY

RAVENSHAW UNIVERSITY

UNDER

CHOICE BASED CREDIT SYSTEM

2021

UG GEOLOGY (State Model Syllabus)

	Code	CORE COURSE	Ability enhancement and compulsory course (AECC)	Ability Enhancement Elective Courses (SEC)	Discipline Specific Elective (DSE)	Elective Course (GE)
I	CC 1	General Geology and Quaternary geology	English communication /Odia/Hindi			GE-I General Geology and Mineralogy
	CC II	Tectonics and Remote Sensing				
II	CC III	Crystallography and Mineralogy	Environmental Science			GE-II Petrology and Historical Geology
	CC IV	Optics and Geochemistry				
III	CC V	Igneous petrology		SEC-I (Field mapping)		GE-III (Structure and Engineering Geology
	CC VI	Sedimentary petrology				
	CC VII	Metamorphic petrology				
IV	CC VIII	Paleontology		SEC-II (Industrial visit)/Quantitative Logical Thinking		GE-IV Applied Geology
	CC IX	Stratigraphy				
	CC X	Structural geology				
V	CC XI	Process of formation and mineral economics			DSE-I (Fuel Geology)	
	CC XII	Economic geology			DSE-II (Climate Change & Disaster Management)	
VI	CC XIII	Groundwater and Engineering geology			DSE-III (Earth and Climate)	
	CC XIV	Mining and Environmental geology			DSE-IV (Project work/Evolution of life through time	
	VA	Water quality Assessment				
	AO	Natural Hazards and Disaster Management				

FIRST SEMESTER

CC1: GENERAL GEOLOGY AND QUATERNARY GEOLOGY

Learning Objective:

Students will be able to:

- Identify the order of the planets.
- Understanding the characteristics of the inner and outer planets.
- Understand Earth's internal structure.
- Describe how wind patterns, the rotation of the Earth, and continents affect surface currents in the ocean.
- Working of the dynamic natural agencies, surface relief features and their evolution
- Understand about tectonic history and landforms of Quaternary times.

Learning Outcomes:

After studying this course, students will be able to:

- Appreciate the celestial bodies and their characteristics
- Understand the Earth's interior, geomagnetism, extrapolation of the interior.
- Students will be able to understand how ocean currents work due to density, salinity, density, Coriolis effect and wind-driven currents.
- The student shall be able to assess the importance of Quaternary Geology in understanding the causes and effects of climate change

Unit - 1: Earth as a Planet

Geology - its perspective, scope and subdivisions; General characteristics and origin of the Universe, Solar System and its planets. The terrestrial and Jovian planets. Meteorites and Asteroids. Earth in the solar system - origin, size, shape, mass, density, rotational and revolution parameters and its age.

Unit II: Internal Structure of the Earth

Seismology and internal structure of the earth; Formation of core, mantle, crust; Convection in Earth's core and its magnetic field. Radioactivity and age of the earth. Volcanoes: Types, products and distribution. Earthquakes - intensity, causes, earthquake belts and distribution. Oceanic current system and effect of Coriolis force; Concept of eustasy; Land-air-sea interaction. Atmospheric circulation, Weather and climatic changes; Earth's heat budget

Unit - 3: Geomorphology

Weathering and Erosion, Mass wasting; Geological works of river, glacier, wind, underground water, ocean and landforms produced by them. Wave erosion and beach processes.

Unit - 4: Quaternary Geology

Scope, climate change, eustatic movement and other geological phenomena during Quaternary; Landforms and deposits with special reference to India; Neotectonics; Glaciation and its causes; Sea-level change during Quaternary.

Practical: Study of geomorphic forms and drainage patterns. Study of contour patterns and drawing of profiles. Study of major ocean currents of the World. Laboratory records and viva voce.

Text Books

Duff, P.M.D., &Duff, D. (Eds.). (1993).Holmes' Principles of Physical Geology. Taylor &Francis.

Suggested Readings:

1. Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.
2. Gross, M. G. (1977). Oceanography: A view of the earth.
3. Invitation to Oceanography (2009) Paul R. Pinet Jones& Barlett Learning
4. Trujilo, A. and Thurman, H. (2012) Essentials of Oceanography, 12th Edition, Pearson

CC2: TECTONICS AND REMOTE SENSING

Learning Objectives:

- Understand relief and elevation.
- Understand the concept of isostasy.
- Students will be able to understand plate motions associated with divergent, convergent, and transform plate boundaries.
- Understand the basic principles of remote sensing.
- Identify the various relief features of the ocean floor.

Learning Outcomes:

- After this lesson, students should be able to:
- Explain the connection between tectonic plates and orogeny and epeirogeny.
- Interpretation and use of aerial photographs
- Use remote sensing in exploration for groundwater, minerals and ores.
- Evolution of submarine geomorphic features

Unit - 1: Earth Movement

Tectonic movements: Epeiorogeny and orogeny; Isostasy – concept and theories; Geosynclines; Mountain building theories; Origin of oceans, continents, mountains and rift valleys

Unit - 2: Plate Tectonics

Plate tectonics–concept and types of plate margins; Continental drift–evidences and causes; Sea floor spreading; Mid-oceanic ridge, trenches, transform faults; Island arc.

Unit - 3: Photogeology and Remote Sensing

Principles of aerial photography; Types and acquisition of aerial photographs; Scale and resolution; Principles of stereoscopy, relief, displacement, vertical exaggeration and distortion, Photo-elements and interpretation. Application of aerial photography in mineral exploration, ground water exploration. Principles of remote sensing, Electromagnetic radiation, Scale, Platforms, Photo mosaic and FCC. Sensors and scanners, Satellites and their characteristics, Data formats-Raster and Vector. Application of remote sensing in mineral exploration, ground water exploration and geomorphology.

Unit - 4: Marine Geology Relief of ocean floor; Marine sediments and their classification; Marine resources; Submarine canyons, Sea mounts and guyots; Coral reef.

Practical: Study of aerial photographs and uses of stereoscopes. Aerial Photo interpretation of various aeolian, glacial, fluvial and marine and forms from aerial photographs. Study of maps of plates, earthquake belts, hot spots, trenches, triple junctions and volcanic belts. Laboratory records and viva voice.

Text Book: Jensen, J.R., 1996. Introductory Digital Image Processing: A Remote Sensing Perspective, Springer- Verlag.

Condie, K.C., Plate tectonics and Crustal Evolution

Suggested Readings:

1. Demers, M.N., 1997. Fundamentals of Geographic Information System, John Wiley & sons.Inc.

2. Hoffmann-Wellenhof ,B., Lichtenegger, H.and Collins,J., 2001.GPS:Theory & Practice, Springer

Wien NewYork.

3. Lillesand, T. M. & Kiefer, R.W., 2007. Remote Sensing and Image Interpretation, Wiley.

4. Richards, J.A. and Jia, X., 1999. Remote Sensing Digital Image Analysis, Springer-Verlag.

5. Kearey, P., Klepeis, K.A. and Vine, F.J., (3rd Edition) Global Tectonics

SECOND SEMESTER

CC3: CRYSTALLOGRAPHY AND MINERALOGY

Learning objectives:

- Learn about Crystals and Elements of crystallography, structural chemistry.
- Learn about minerals and their properties

Learning outcomes:

After successfully completing the course, the student will be able to:

- Differentiate between crystalline and amorphous solids; recognize symmetry elements of present in crystal Systems, simple crystal structures;
- Represent crystals onto stereo nets.

Unit - 1: Crystallography

Crystalline and non-crystalline substances, Crystals - definition, characteristics, intercepts, Parameters, indices and forms. Symmetry elements and classification of crystals in to six systems. Hermann-Mauguin symbol; Holohedrism, hemihedrism hemi morphism and enantiomorphism. Study of axial relationship, symmetry elements and forms present in 4/m 32/m, 43m, 2/m 3, 4/m2/m2/m, 6/m2/m2/m, 32/m, 2/m2/m2/m, 2/m and 1 classes. Fundamentals of stereographic projection of crystals. Zone and zonal laws, Twinning.

Unit - 2: Physical and chemical mineralogy

Scope of mineralogy; chemical bonding and compound formation. Definition and classification of minerals. Physical properties of minerals, Silicate structure and its classification.

Unit - 3: Silicate minerals

Study of atomic structure, chemistry, physical, optical properties and uses of minerals of Olivine, Feldspar, Pyroxene, Amphibole, Garnet and Mica groups.

Unit - 4: Descriptive Mineralogy

Isomorphism, polymorphism and pseudo morphism; Chemical composition, physical and optical properties and uses of agate, amphibole, anatase, andalusite, anhydrite, apatite, aragonite, augite, barite, beryl, biotite, calcite, chlorite, corundum, diamond, diopside, dolomite, enstatite, epidote, fluorite, garnet, gypsum, halite, hornblende, hypersthene, kyanite, magnesite, microcline, monazite, muscovite, olivine, orthoclase, plagioclase, quartz, rutile, sanidine, serpentine, sillimanite, sphene, staurolite, talc, topaz, topaz, tourmaline, and zircon.

Practical: Study and identification of crystal models as mentioned in theory. Megascopic Identification of rock forming minerals as mentioned in theory, Laboratory records and viva voce.

Text Books:

1. Optical Mineralogy – The non-opaque minerals, W. R. Phillips and D. T. Griffen (2004), CBS Pub. & Dist., New Delhi
2. Rutley's Elements of Mineralogy (27th Edition) Revised by C.D. Gribble
3. Practical approach to crystallography and mineralogy, R. N. Hota (2011), CBS Pub. & Dist., New Delhi

CC 4: OPTICS AND GEOCHEMISTRY

Learning objectives:

- Understand the behaviour of light in a medium.
- The course aims to introduce to chemical principles in explaining the mechanisms that control the large geological processes in the Earth´s mantle, crust, ocean and atmosphere, and the the solar system.

Learning outcomes:

The students can be able to

- Characterize different minerals under a petrological microscope.
- Explain fractionation of stable isotopes and how such data can be used to understand various geochemical and geobiological processes
- Describe how radiogenic isotope signatures can be used to trace the source of minerals, rocks and fluids.

Unit - 1: Nature of light

Nature of light rays and their propagation, internal reflection, double refraction, interference and polarization. Nicol Prism and polaroids. Petrological microscope - parts and their functions. Preparation of thin section of minerals and rocks.

Unit - 2: Mineral optics

Behaviour of light in thin section and production of interference colours. Order of interference colour, twinkling, Optic axis, Uniaxial and biaxial minerals. Isotropsim and anisotropism, Extinction and extinction angle. Pleochroism, pleochroic scheme, Birefringence; Outline of study of optical characters of minerals in thin sections.

Unit - 3: Concept of geochemistry

Chemical bonding, states of matter and atomic environment of elements. Cosmic abundance of elements; composition of planets and meteorites. Structure and composition of earth. Conservation of mass, isotopic and elemental fractionation. Concept of radiogenic isotopes in geochronology and isotopic tracers.

Unit - 4: Cosmic abundance of elements

Geochemical classification of elements, Primary geochemical differentiation; Atomic substitution. Advection and diffusion; Chromatography; Elements of marine chemistry; Mineral reactions diagenesis and hydrothermal reactions. Distribution of elements in solar system; Chemical differentiation and composition of the Earth; General concepts about geochemical cycles and mass balance; Geo-chemical behaviour of major elements.

Practical: Microscopic identification of rock forming minerals; Measurement of extinction angle; sign of elongation and order of interference colour. Laboratory records, Field report and viva voce.

Text Books:

1. Dexter Perkins (2002) Mineralogy, Prentice-Hall of India, New Delhi.

Suggested Readings:

1. Klein,C.,Dutrow,B.,Dwight,J.,&Klein,C.(2007).The23rdEditionoftheManual of Mineral Science (after James D. Dana). J. Wiley &Sons.
2. Kerr, P. F. (1959). Optical Mineralogy. McGraw-Hill.
3. Verma, P.K.(2010).Optical Mineralogy(Four Colour). Ane Books Pvt. Ltd.
4. Deer, W.A., Howie, R.A., & Zussman, J. (1992).An introduction to the rock-forming minerals (Vol. 696). London: Longman.
5. Hota, R. N. (2017) Practical approach to crystallography and mineralogy, CBS Publishers and Distributors, New Delhi

THIRD SEMESTER

CC 5: IGNEOUS PETROLOGY

Learning objectives:

- This is an introductory course to provide a basic understanding of the different groups of igneous rocks and the processes involved in their formation.
- The course reviews igneous activity in different tectonic environments, including continental rifts, oceanic spreading ridges and subduction zones as well as in tectonic plates.

Learning outcomes:

The students can be able to

- Describe and interpret the texture and structure of igneous rocks.
- Explain the physical processes of magma formation

- Understanding magmatic differentiation and assimilation process and how diverse genera of rocks formed.

Unit - 1: Concepts in Igneous Petrology

Introduction to petrology: Heat flow, geothermal gradients through time. origin and nature of magma; Magma generation in crust and mantle, their emplacement and evolution. Magmatism in the oceanic domains (MORB, OIB); Crystallization behaviour of unicomponent magma; bicomponent magma showing solid solution and eutectic relationships.

Unit-2: Forms of Igneous Rocks

Introduction, Forms, Texture, Mega-and micro-structures of igneous rocks. Mode of occurrence of igneous rocks

Unit-3: Diversity of Igneous rocks

Bowen's reaction series and its implications. Differentiation of magma and diversity of igneous rocks. Introduction to Di-Ab-Binary system; Classification of igneous rocks. Preliminary idea on assimilation processes. Magmatism along the plate margins (Island arcs/continental arcs).

Unit-4: Igneous Petrography

Petrogenesis of Felsic and Mafic igneous rocks; Petrographic notes on Basalt, Dolerite, Gabbro, Granite, Pegmatite, Syenite, Dunite, Diorite, Peridotite, Carbonatite, Anorthosite and Kimberlite and their occurrences in India..

Practical: Megascopic and microscopic identification of important igneous rocks. Laboratory records and viva voice.

Text Book:

1. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
2. G W Tyrrell. (1926). Principles of Petrology. Springer

Suggested Readings:

1. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
2. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Rout ledge.
3. Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks.
4. Birney, A. R. (1984). Igneous Petrology. San Francisco (Freeman, Cooper & Company) and Oxford (Oxford Univ. Press),
5. Myron G. Best (2001). Igneous and Metamorphic Petrology,
6. Bose M.K. (1997). Igneous Petrology.
7.Hota, R.N. (2017) Practical approach to petrology, CBS Publishers and Distributors,

CC 6: SEDIMENTARY PETROLOGY

Learning objectives:

- The purpose of this course is to understand how sedimentary rocks are formed.
- This starts with understanding sediment composition and how this can be used to infer source area characteristics.
- Structure and texture of sedimentary rocks, their chemical and physical transformations that lead to major changes in the original petrophysical (porosity and permeability) characteristics

Learning Outcomes:

Learning outcomes and competences, it is intended that students can:

- Will be able to identify and understand the sedimentary rocks in the context of the dynamics of the geological processes
- Will be able to describe and classify the sedimentary rocks;
- Will be able to interpret the processes of weathering, transportation and deposition of the sedimentary materials forming the rocks;
- Recognize and characterize different sedimentary rocks from their petrography.

Unit - 1: **Origin of sediments**

Introduction, formation of sediments and sedimentary rocks. Elementary idea on sedimentary Environments. Compaction, cementation and diagenesis

Unit - 2: Sedimentary textures, structures and environment

Texture and fabric of sedimentary rocks. Fluid flow, sediment transport and sedimentary structures: Types of fluids, Laminar vs. turbulent flow, Particle entrainment, transport and deposition. Elementary idea on sedimentary facies and environment.

Unit - 3: Sedimentary provenance and basins

Classification of sedimentary rocks; sandstone and limestone; Palaeocurrent, Heavy minerals and Provenance. Sedimentary basins of India (Marine)

Unit - 4: Sedimentary Petrography

Petrographic notes on sandstones, conglomerate, shale, limestone and breccia and their occurrences in India. Dolomite and dolomitisation

Practical: Megascopic and microscopic identification of sedimentary rocks. Exercises on Sedimentary structures, Paleocurrent analysis; Laboratory records and viva voce.

Text Book: Nichols, G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley Blackwell

Suggested Readings:

1. Prothero, D.R., & Schwab, F. (2004). Sedimentary geology. Macmillan.
2. Tucker, M. E. (2006) Sedimentary Petrology, Blackwell Publishing.
3. Collinson, J. D. & Thompson, D. B. (1988) Sedimentary structures, Unwin- Hyman, London.
4. Hota,R.N.(2017)Practical approach to petrology, CBS Publishers and Distributors, NewDelhi

CC7: METAMORPHIC PETROLOGY

Learning Objectives:

- The study of metamorphic rocks encompasses the chemical and physical transformations that take place in response to changing pressure, temperature, and chemical environment in the Earth's interior.
- In this course, different petrogenetic processes involving mineral reactions will be explored.

Learning Outcomes:

Having successfully completed this module you will be able to:

- Describe the origin of metamorphic rocks. Distinguish between the processes that produce various types of metamorphic rocks.
- 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.
- Recognize and characterize different metamorphic rocks from their petrography.

Unit - 1: Metamorphism: controls and types

Introduction, Definition of metamorphism. Factors controlling metamorphism: Agents and types of metamorphism, ACF and AKF diagrams.

Unit - 2: Metamorphic facies and grades

Index minerals, Metamorphic zones and grades. Concept of metamorphic facies; Mineralogical phase rule of closed and open system; Structure and textures of metamorphic rocks.

Unit - 3: Metamorphism and Tectonism

Relationship between metamorphism and deformation; Metamorphic mineral reactions (prograde and retrograde); Migmatites and their origin; Metasomatism and role of fluids in metamorphism. Classification of metamorphic rocks; Metamorphic differentiation.

Unit - 4: Metamorphic Petrography

Petrographic notes on important rock types like schists, gneisses, marble, quartzite, slate, phyllites, khondalite and charnockite, eclogites and their occurrences in India.,

Practical: Megascopic and microscopic identification of metamorphic rocks. Laboratory records and viva voce.

Text Book: Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Earth Science Series.

Suggested Readings:

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

FOURTH SEMESTER

CC 8: PALAEONTOLOGY

Learning Objectives:

- Invertebrate paleontology was once called the 'handmaiden of stratigraphy' because of the usefulness of fossils for correlating sedimentary strata.
- Fossils provide information needed to solve a variety of other geological problems.
- However, paleontology is also fascinating in itself as the study of the history and evolution of life.
- Thus, we will learn to identify and use fossils as geological tools, and we will learn how paleontologists analyze fossils to interpret the history of life on Earth.

Learning Outcomes:

- Identify different fossils from their morphology
- Pigeonhole them in different geologic stratigraphic horizons.

Unit - 1: Fossilization and fossil record

Fossil-definition and conditions of fossilization; Mode of preservation and geological significance of fossils.

Unit - 2: Invertebrate Palaeontology

Morphology and geological history of Trilobita, Brachiopoda, Pelecypada, Cephalopoda, Gastropoda, Echinoidea, Coral and Graptolite.

Unit - 3: Vertebrates Palaeontology

Origin of vertebrates and major steps in vertebrate evolution. Mesozoic reptiles with special reference to origin diversity and extinction of dinosaurs; Siwalik fauna Evolution of horse and intercontinental migrations. Human evolution.

Unit - 4: Palaeobotany

Scope of paleobotany, taxonomy of plants, Gondwana flora and their significance. Separation of spores and pollens and mounting for study. Utility of palynological studies in different fields.

Practical: Identification of important invertebrate and plant fossils; Drawing and labeling of fossils; Arrangement of fossils in chronological order; Laboratory records and viva voce.

Text Book: Clarkson, E.N.K.(2012) Invertebrate paleontology and evolution 4th Edition, Blackwell Publishing.

Suggested Readings

1. Raup,D.M.,Stanley,S.M.,Freeman,W.H.(1971)Principles of Paleontology
2. Benton, M. (2009). Vertebrate paleontology. John Wiley &Sons.
3. Shukla, A.C.& Misra,S.P.(1975).Essentials of paleobotany. Vikas Publisher
4. Armstrong, H. A., & Brasier, M.D. (2005) Microfossils. Blackwell Publishing.

CC 9: STRATIGRAPHY

Learning Objectives:

- 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

Learning Outcomes:

The student would learn

- Stratigraphic sequence of different geologic formations
- Recognise their palaeontological records and their economic prospect

Unit - 1: Principles of stratigraphy

Principles of Stratigraphy, Stratigraphic units; Stratigraphic correlation, Standard stratigraphic time scale and Indian equivalences; Geomorphic and tectonic divisions of India.

Unit - 2: Code of stratigraphic nomenclature

Indian code of stratigraphic nomenclature. Concepts of Stratotypes. Global Stratotype Section and Point (GSSP). Brief introduction to the concepts of lithostratigraphy, biostratigraphy, chrono-stratigraphy, seismic stratigraphy, chemo stratigraphy, Magneto stratigraphy, Sequence stratigraphy

Unit - 3: Precambrian stratigraphy
Precambrian stratigraphy of Karnataka, Odisha, Jharkhand, Rajasthan, Madhya Pradesh and Maharashtra. Stratigraphy of Cuddapah and Vindyanbasins.

Unit - 4: Paleozoic, Mesozoic and Cenozoic stratigraphy of India
Gondwana rocks with special emphasis on fossils, climate and economic importance. Triassic of Spiti, Jurassic of Kutch and Cretaceous of Trichinopoly. Deccan trapsand Tertiary of Assam. Siwalik rocks.

Practical: Drawing of stratigraphic units in outline map of India and Odisha; Identification and interpretation of stratigraphic assemblages; Laboratory records and viva voice.

Text Book:

1. Ramakrishnan,M. and Vaidyanadhan,R.(2008)GeologyofIndiaVolumes1& 2, Geological society of India, Bangalore.

Suggested Readings:

1. Krishnan,M.S.(1982)Geology of India and Burma, CBS Publishers, Delhi
2. Doyle, P.& Bennett,M.R.(1996)Unlocking the Stratigraphic Record. John Wiley
3. Valdiya,K.S.(2010)The making of India, Macmillan India Pvt. Ltd.

CC 10: STRUCTURAL GEOLOGY

Learning Objectives:

- Understand stress and strain
- The course aims to introduce undergraduate students to its basic principles, analysisand field characteristics.
- Students develop a basic appreciation of rock deformation at different temperatures and pressures and at various scales and understand the difference between brittle and ductile deformation regimes.
- Students study diverse geometries and types of structures in the field and learn to relate them to the deformation regime.

Learning Outcomes:

- demonstrates a basic understanding of stress, strain and rheology of Earth's lithosphere

- comprehend how to describe and classify brittle and ductile structures, including faults and folds
- knows how mountain ranges and rift basins form
- Knows how to read simple geological maps and geological cross-sections.

Unit - 1: Rock deformation
Introduction, Attitude of beds; V's rule; Deformation, concept of stress and strain; Strain ellipses of different types and their geological significances. Effects of topography on structural features, Topographic and structural maps; Importance representative factors of the map. Outlier, Inlier, Nappe, Klippe and Window.

Unit - 2: 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 - 3: 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 - 4: Unconformities, Foliation and Lineation
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.

Practical: Interpretation of structure, stratigraphy and geologic history from maps; Drawing of sections; Completion of outcrops; Three point problems; Thickness and depth problems; Laboratory records, field report and viva voice.

Text Book: Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley

Suggested Readings:

1. Billings, M.P.(1987)Structural Geology,4thedition,Prentice-Hall.
2. Park, R.G.(2004)Foundations of Structural Geology. Chapman & Hall.
3. Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.
4. Ragan, D. M. (2009) Structural Geology: an introduction to geometrical techniques (4th Ed). Cambridge University Press (For Practical)
5. Lahee, F. H. (1962) Field Geology. Mc Graw Hill

FIFTH SEMESTER

CC 11: PROCESSES OF FORMATION AND MINERAL ECONOMICS

Learning Objectives:

Students will be able to

- know the importance of minerals to society
- know factors that control availability of mineral resources
- know why future world mineral supply and demand is an important issue
- understand the environmental impact of mining and processing of minerals

Learning outcome:

- 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-1: Magmatic and hydrothermal processes

Process of formation of ore bodies: Magmatic concentration, Hydrothermal processes, Wall rock alteration and Paragenesis, Zoning.

Unit - 2: Secondary processes

Process of formation of ore bodies: Residual and mechanical concentration, Oxidation and Supergene enrichment. Process of formation of ore bodies: Sedimentation, Evaporation, Metamorphism.

Unit - 3: Energy Resources and Mineral Economics

Origin, occurrence, distribution and uses of coal and petroleum; Atomic minerals.

Unit - 4: Mineral Economics

Strategic, essential and critical minerals. Sustainable developments of minerals; Conservation of mineral resources.

Practical: Megascopic study of strategic, critical and essential minerals. Laboratory records and viva voce.

Text Book:

1. Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.

4. Tiwari, S.K. Ore Geology, Economic Minerals and Mineral Economics

Suggested Readings:

1.. Guilbert, J.M. and Park Jr., C.F. (1986) The Geology of Ore deposits. Freeman & Co.

2. Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley

CC 12: ECONOMIC GEOLOGY

Learning Objectives:

- Understanding the genesis and localization of ore deposits and the associated minerals.
- This course covers the distribution, geological setting and genesis of important metalliferous mineral deposits.
- Factors controlling the formation of these deposits
- Practical work involves megascopic identification, uses and Indian distribution of important ores and study of a range of minerals and ores.

Learning Outcomes:

Upon successful completion, students will have the knowledge and skills to:

- Recognise common ore minerals in hand specimen and under the microscope.
- Learn about their uses and utility in the society

Unit - 1: Ores and Gangue

Ores, gangue minerals; tenor and grade; Resources and reserves, Metallogenic epoch and provinces of India. Controls of ore localization, Classification of mineral deposits; Ore districts.

Unit - 2: Mineral Exploration

Exploration and exploitation techniques; Geological, Geophysical and Geochemical Explorations, Geological mapping at different scales, drilling, borehole logs.

Unit - 3: Metallic Minerals

Mineralogy, mode of occurrence, origin, Indian distribution and uses of ores of Fe, Mn, Al, Cr, Cu, Pb and Zn ores. Important ore deposits of India

Unit - 4: Industrial minerals

Mineralogy, mode of occurrence, origin, Indian distribution and uses of Mica, Asbestos, Kyanite, Sillimanite, Graphite, Baryte, Serpentinite and Magnesite and Limestone.

Practical: Megascopic identification and uses of important metallic and non-metallic minerals; Distribution of important ores and other economic minerals in India. Laboratory records and viva-voce.

Text Book: Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.

Suggested Readings:

1. Guilbert, J.M. and Park Jr., C.F.(1986)The Geology of Ore deposits. Freeman &Co.
2. Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley
3. Laurence Robb. (2005) Introduction to ore forming processes. Wiley.

4. Gokhale, K.V.G.K. and Rao, T.C. (1978)Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.
5. Deb,S.(1980)Industrial minerals and rocks of India. Allied Publishers.
6. Sarkar, S.C. and Gupta, A. (2014) Crustal Evolution and Metallogeny in India. Cambridge Publications.

SIXTH SEMESTER

CC13: GROUND WATER AND ENGINEERING GEOLOGY

Learning Objectives:

Students will be able to:

- Understand what groundwater is and where it is derived from.
- Understand key terminology associated with groundwater processes, including aquifer; water table, infiltration and porosity
- Understand issues associated with the management and use of groundwater supplies
- 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 constructing dams.

Learning Outcomes:

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

- Describe how the water table can vary seasonally and/or due to changes in climate conditions.

- Students will be able to understand the behaviour of material under different loading.
- Students will be able to understand the property, use, advantage and disadvantage of different material used in construction.
- Students will be able to classify soils

Unit - 1: Water bearing characteristics

Hydrological cycle, vertical zonation of ground water, Properties of water bearing formations porosity, permeability, specific yield, specific retention, storativity. Aquifer types-Confined and unconfined aquifers, aquitard, aquiclude, aquifuse. Darcy's law.

Unit - 2: Groundwater exploration and quality

Ground Water exploration - types of wells, groundwater provinces of India and Odisha. Seawater intrusion, Quality of ground water and its use in domestic, agriculture and industries; Ground water pollution.

Unit - 3: Engineering properties of materials and geology of dams

Introduction, engineering properties of rocks and soils, Types of dams; Geological considerations of Dam and reservoir site selection.

Unit - 4: Geology of tunnel and bridge

Geological considerations of tunnel alignment, bridge site selection. Earthquake resistant structures, Soil - classification, erosion and conservation.

Practical: Problems related to groundwater and engineering properties of rocks. Laboratory records and viva voice.

Text Book:

1. Raghunath H.M., Hydrology
2. Todd, D.K. Groundwater Hydrogeology
3. Singh S., Fundamentals of Hydrology
4. Parvin Singh, Engineering and General Geology
5. Gangopadhy, S., Engineering Geology

Suggested Reading:

1. Kumar R., Groundwater and Well Drilling
2. Davie T., Fundamentals of Hydrology
3. N.SubbaRao, Hydrogeology Problems and Solutions
4. Bell, F.G. Engineering Geology
5. Fetter, C.W. Applied Hydrogeology

CC 14: MINING AND ENVIRONMENTAL GEOLOGY

Learning Objectives:

After completing, students will be able to:

- Understand various types of mining methods.
- Summarize the environmental impact of different types of mining
- Understand the objectives, features and reporting of mineral prospect and mine evaluations and the preproduction, production and consulting responsibilities of the mining geologist.
- Describe the occurrence and formation of earth resources and significant environmental effects caused by their extraction, processing, and use.

Learning Outcomes:

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

- Understand the common earth materials and their relationship to environmental hazards
- Explain how earth processes create hazards to life and property; and
- Describe the major sources of water, soil, and sediment pollution and methods for their management
- Explain the causes and effects of global climate change.
- Apply the knowledge gained in the context of mineral exploration, prospect evaluation and mining

Unit - 1: Mining
Terminology in mining, opencast and Underground mining methods, Drilling, Surveying; Sampling; Assaying and ore reserve estimation

Unit - 2: Disaster Management
Natural disasters and their management–Earthquake, Landslide, Flood, Tsunami and Cyclone.

Unit - 3: Resource Management
Renewable and non-renewable resources; Conservation of mineral resources; Impact of mining on environment; Fundamentals of environmental impact assessment.

Unit - 4: Environmental Geology
Management of solid wastes including mining wastes; Fly ash, Radioactive wastes; Environmental protection- Legislative measures in India; Fluorosis problems and arsenic poisoning in India – Causes and remedial measures.

Practical: Borehole problems, assay and ore reserve estimation. Laboratory records, Field report and viva voce.

Text Book:

1. Smith, K., 1992. Environmental Hazards. Routledge, London.
2. Valdiya, K. S. (1987) Environmental geology, Tata McGrow Hill, New Delhi
3. Arogyaswami, Mining geology

Suggested Reading:

1. Bell, F.G., 1999. Geological Hazards, Routledge, London.
2. Bryant, E., 1985. Natural Hazards, Cambridge University Press.
3. Subramaniam,V.,2001.Textbook in Environmental Science, Narosa International

DISCIPLINE SPECIFIC ELECTIVE
DSE I: FUEL GEOLOGY

Learning Objectives:

Students will be able to:
- To learn about coal forming processes, classification, and analysis
- Get knowledge of Indian coal deposits
- To learn on 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:

- Chemical and physical properties of hydrocarbons.
- Hydrocarbon basins in India.
- Distinguish between different types of coal based on physical, chemical and petrographical and other properties

Unit 1: Coal

Definition and origin of coal; Classification of coal. Fundamentals of Coal Petrology - Introduction to lithotypes. Proximate and ultimate analysis

Unit 2: Coal as a fuel

Coal Bed Methane (CBM): global and Indian scenario; Underground coal gasification; Coal liquefaction

Unit 3: Petroleum

Chemical composition and physical properties of crude petroleum. Origin of petroleum; Maturation of kerogen; Biogenic and Thermal effect

Unit 4: Petroleum Reservoirs and Traps

Reservoir rocks: general attributes and petro-physical properties. Classification of reservoir rocks-clastic and chemical. Hydrocarbon traps: definition, anticlinal theory and trap theory. Classification of hydrocarbon traps - structural, stratigraphic and combination. Time of trap formation and time of hydrocarbon accumulation. Cap rocks - definition and general properties. Plate tectonics and global distribution of hydrocarbon reserves.

PRACTICALS

1.Study of hand specimens of coal
2.Reserve estimation of coal
3.Section correlation and identification of hydrocarbon prospect
4.Panel and Fence diagrams

Text Book:

1. Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.

SUGGESTED READINGS:

1. Shelly R.C.(2014).Elements of Petroleum geology: Third Edition, Academic Press
2. Bjorlykke, K.(1989).Sedimentology and petroleum geology. Springer-Verlag.
3. Bastia, R.,& Radhakrishna, M.(2012).Basin evolution and petroleum prospectivity of the continental margins of India (Vol. 59). Newnes.

DSE 2: CLIMATE CHANGE AND DISASTER MANAGEMENT

Learning Objectives:

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

Learning 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 1: Natural disasters and their management

Drought, Flood, Cyclone, Tornado, Thunder storm; Earthquake, Land slide, Tsunami, Inundation of Coastlines

Unit 2: Elements of Climatology

Thermal Structure & Composition of Atmosphere; Elements of Climate and weather

Unit 3: World Weather Circulation

Jet stream and its influence on world weather; Air Mass, their classification and influence on world weather; Fronts (Front classification).

Unit 4: Climate Change

Glacial periods, sea-level rise, effects of sea level rise, Rise of carbon dioxide in the atmosphere, green house gases, green house effect and global warming, Desertification

Practical: Tutorials and Seminar

Text Book: Bell, F.G., 1999. Geological Hazards, Routledge, London.

Suggested Readings:

1. Bryant, E., 1985. Natural Hazards, Cambridge University Press.
2. Smith, K., 1992. Environmental Hazards. Routledge, London

DSE 3: EARTH AND CLIMATE

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 and glacial-interglacial stages.

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.

Unit- 1: Climate system

Forcing and Responses Components of the climate system, Climate forcing, Climate controlling factors, Climate system response, response rates and interactions within the climate system Feedbacks in climate system. Response of biosphere to Earth's climate; Climate Change: natural vs. anthropogenic effects; Humans and climate change; Future perspectives; Brief introduction to archives of climate change; Archive based climate change data from the Indian continent

Unit - 2: Heat budget of Earth and Monsoons

Incoming solar radiation, receipt and storage of heat; Heat transformation; Earth's heat budget. Interactions amongst various sources of earth's heat; Mechanism of monsoon; Factors associated with monsoonal intensity; Effects of monsoon

Unit - 3: Atmosphere - Hydrosphere

Layering of atmosphere and atmospheric Circulation; Atmosphere and ocean interaction and its effect on climate; Heat transfer in ocean; Global oceanic conveyor belt and its control on earth's climate; Surface and deep circulation.

Unit - 4: Glacial Periods

Milankovitch cycles and variability in the climate; Glacial-interglacial stages; The Last Glacial maximum (LGM); Pleistocene Glacial-Inter glacial cycles, Younger Dryas; Marine isotope stages

Practical

1. Study of distribution of major climatic regimes of India on map
2. Distribution of major wind patterns on World map

3. Preparation of paleo geographic maps (distribution of land and sea) of India during specific geological time intervals

Text Book: Rudiman, W.F., 2001. Earth's climate: past and future. Edition 2, Freeman Publisher.

Suggested Readings:

1. Rohli,R.V.,andVega,A.J.,2007.Climatology.JonesandBarlatt
2. Lutgens, F., Tarbuck, E., and Tasa, D., 2009. The Atmosphere: An Introduction to Meteorology. Pearson Publisher
3. Aguado, E., and Burt, J., 2009. Understanding weather

DSE4: PROJECT/ EVOLUTION OF LIFE THROUGH TIME

Learning Objectives:

After completing, students will be able to:

- Learn about the early stages of life on Earth from a scientific perspective, and learn about the characteristics of different organisms that existed during major timelines in history.

Learning Outcomes:

- Upon successful completion of the course, students will be able to have a better understanding of how evolutionary history of life proved by way of hypothesis testing, systematic observations and the comparative methods

Unit I: Origin of life

Possible life sustaining sites in the solar system, Archaean life: Earth'soldest life, Transition from Archean to Proterozoic, the oxygen revolution and radiation of life Precambrian macrofossils–The garden of Ediacara, The Snow Ball Earth Hypothesis

Unit II: Life through ages

Fossils and chemical remains of ancient life. Geological Time Scale with emphasis on major bio events. Biogeochemical cycles Abundance and diversity of microbes, extremophiles Microbes-mineral interactions, microbial mats

Unit III: Life in Paleozoic

The Cambrian Explosion. Bio mineralization and skeletalization, Origin of vertebrates and radiation of fishes, Origin of tetra pods Life out of water, Early land plants and impact of land vegetation

Unit IV: Life in Mesozoic and Cenozoic

Life after the largest (P/T) mass extinction, life in the Jurassic seas, Origin of mammals, Rise and fall of dinosaurs, Origin of birds; and spread of flowering plants, After math of end Cretaceous mass extinction–radiation of placental mammals Evolution of modern grasslands and co evolution of hoofed grazers Rise of modern plants and vegetation

PRACTICAL

1. Study of modes of fossil preservation
2. Study of fossils from different stratigraphic levels
3. Exercises related to major evolutionary trends in important groups of animals and plants

Suggested Readings:

1. Stanley, S.M.,2008 Earth System History
2. Jonathan I. Lumine W.H. Freeman Earth-Evolution of a Habitable World, Cambridge University Press.
3. Canfield, D.E.& Konhauser, K.O.,2012 Fundamentals of Geo biology Blackwell
4. Cowen, R.,2000 History of Life, Blackwell

PROJECT WORK (6 Credits): Full marks 100

Preamble of Project Work

Geology is essentially a field science and a part of the knowledge is gained from study of Exposures in the field. The project work has been envisaged to give the students an actual feel of working condition in the field. He/she can have hands on experience in locating himself in the field, study different types of rocks, their texture, structure and inter-relationship, find out attitudes of beds, differentiate various geological structures, stratigraphy etc. In the field, the student can acquaint himself with different exploration procedures including drilling and logging of cores. Visit to different opencast and underground mines can provide comprehensive account on occurrence of mineral deposits in nature, requisites of different mining conditions, mineral engineering and ore dressing practices. The student can obtain hands on experience in cutting edge technologies like XRD, Ion chromatography, FESEM-EDAX, XRF from visit to different technological laboratories.

Finally, from visit to different mineral-based plants and industries the student can gain knowledge on various extraction processes. In view of the above, the student can take up project work on any of the above aspects under the supervision of a teacher, in which the theoretical knowledge can be substantially augmented.

Field study should be treated as the project work.

Each year the students should go for field study commensurate with the theory subjects under the guidance of one or more teachers. They should map an area and study the petrographic and structural aspect of the rocks. Further they may visit mines, mineral/ rock based industries, engineering projects and areas of palaeontological importance.

SKILL ENHANCEMENT COURSE
SEC-I

Field Geology

Definition, study of the exposures; primary and secondary features, demarcation and measurement of dip, strike, lineation etc. Identifying different types of rocks from the surface exposure, identification of primary sedimentary structures, observation of various structural features like folds, faults, unconformities, joints, lineation, foliation etc and their plotting on various diagrams. Identification of different pene-contemporaneous features like microfolding, microfaulting, slumping warping and other macroscopic features. Tracing the lateral continuity of lithological contacts.

Sampling types and procedure, traversing in the field, visit different metalliferous and non-metallic mines to study the nature of mineralisation, the shape, size and lateral and vertical continuity of the mineralised zone. To understand various drilling methods and mining techniques.

SKILL ENHANCEMENT COURSE
SEC-II

Quantitative Logical Thinking

GENERIC ELECTIVE

GE-I: GENERAL GEOLOGY AND MINERALOGY

Unit-1: General geology and geomorphology
Scope and subdivisions of Geology; Origin, age and interior of the Earth; Earthquake and volcanoes. Weathering and erosion; Geological work of river, wind, glacier and underground water.

Unit-2: Crystallography
Crystalline and non-crystalline substances; Symmetry elements, parameters and indices; Classification of crystals into six systems. Symmetry elements and forms of normal classes of isometric, tetragonal and orthorhombic systems.

Unit - 3: Mineralogy
Minerals: definition and classification; Study of physical and chemical characters of rock forming minerals like quartz, feldspar, pyroxene, amphibole, garnet, olivine

Unit - 4: Optical Mineralogy
Nature of light rays; Polarization, Double refraction, isotropism, anisotropism, Nicol prism, Petrological microscope; Behaviour of light in thin section; Birefringence; pleochroism, extinction angle and interference colours.

Practical: Identification of crystal models with respect to axis, symmetry and forms; Megascopic and microscopic identification of minerals mentioned in theory. Laboratory record and viva-voce.

Text Book: Mukherjee, P. K., Text Book of Geology, World Press

GE-II: PETROLOGY AND HISTORICAL GEOLOGY

Unit–1: Igneous and metamorphic petrology
Forms and texture of igneous rocks; Bowen's reaction series; Classification of igneous rocks; Magmatic differentiation; Petrography of granite, syenite, peridotite, anorthosite, gabbro, dolerite and basalt. Metamorphism: definition, agents, types. Petrography of schists, gneisses, marble, charnockite and khondalite.

Unit – 2: Sedimentary Petrology
Formation of sedimentary rocks; Texture, structure and classification of sedimentary rocks. Petrography of conglomerate, breccia, sandstone, shale and limestone.

Unit - 3: Palaeontology
Fossilisation and uses of fossils; Morphology and geologic history of trilobite, brachiopod, pelecypod, gastropod, cephalopod. Gondwana flora.

Unit - 4: Stratigraphy
Definition and scope of stratigraphy. Stratigraphic units and correlation. Physiographic division of Indian subcontinent. Stratigraphy of type areas of Archaeans, Cuddapah, Vindhyan, Triassic, Jurassic, Cretaceous and Gondwanas.

Practical: Megascopic and microscopic identification of igneous, sedimentary and metamorphic rocks as mentioned in theory. Morphological study of invertebrate and plant fossils mentioned in theory; drawing and labelling of fossils. Laboratory record and viva voce.

Text Book: Mukherjee, P. K. Text Book of Geology, World Press

GE-III STRUCTURE AND ENGINEERING GEOLOGY

Unit-1: Structural Geology and Geotectonics
Strike and dip; Fold: geometry, classification, recognition and causes of folding; Fault: geometry, classification and recognition. V's rule. Unconformity: definition, types, significance and classification. Elementary idea about foliation and lineation. Orogeny and epeiorogeny; Plate tectonics, continental drift; Isostasy; mid oceanic ridge, geosynclines.

Unit - 2: Groundwater
Hydrologic cycle; vertical distribution of groundwater; porosity and permeability; types of aquifers; Darcy's law. Quality of groundwater and its use; groundwater provinces of India.

Unit - 3: Engineering Geology
Engineering properties of rocks; Geological and geotechnical studies of dam, reservoir and tunnel. Earthquake resistant structures.

Unit - 4: Environmental Geology
Renewable and non-renewable resources; Conservation of mineral resources; Impact of mining on environment; Management of solid wastes including mining wastes.

Practical: Interpretation of structure, stratigraphy and geologic history from maps; Drawing of sections; Completion of outcrops; Identification of building stones and their uses. Laboratory records and viva voice.

Text Book:
1. Mukherjee, P. K. (1997) Text Book of Geology, World Press, Kolkata

2. Sinha, R.K.and Sharma,N.L(1980)Mineral Economics, Oxford and IBH, New Delhi

GE-IV APPLIED GEOLOGY

Unit - 1: Ore Genesis

Ore mineral, gangue, tenor and grade; Processes of formation of mineral deposits: Magmatic, Hydrothermal, Mechanical and residual concentration, oxidation and supergene sulphide enrichment.

Unit - 2: Prospecting

Geological, geophysical and geochemical prospecting methods; Controls of ore localization; Metalogenic Epoch and Provinces; Ore reserve estimation.

Unit - 3: Mining and Resource Evaluation

Open cast and underground mining methods; sampling methods and ore reserve estimation; Origin, occurrence, distribution and uses of coal and petroleum.

Unit - 4: Mineral Resources

Mineralogy, mode of occurrence, distribution and uses of ores of Fe, Mn, Cr, Cu and Al ores. Mineralogy, mode of occurrence, origin, Indian distribution and uses of Mica and Asbestos.

Practical: Megascopic identification and uses of important metallic and non-metallic minerals mentioned in theory; Laboratory records and viva voice.

Text Book:

1. Sen, A.K. and Guha, P.K. (2006) A hand book of economic geology, Modern Book Agency, Kolkata

2. Sinha, R. K. and Sharma, N. L (1980) Mineral Economics, Oxford and IBH, New Delhi

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

Course Objectives:

- The course objectives is to introduce the students to the problem of water quality
- Acquaint the student to various methods of water quality analysis.

Course Outcomes:

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

- Undertake water quality analysis using various instrumental techniques
- Data representation

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 by pH meter, Estimation of electrical conductivity by conductivity meter, Estimation of temperature by 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, and 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 Important 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 Disasters

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