

# Department of Geology, Utkal University

## Objective and Outcome

### 1st semester

#### **1AGLC1: Crystallography, Mineralogy and Mineral optics**

Crystallography	Concept of lattice network, Bravais lattices, X-ray study of crystals, Crystal projection, Derivation of 32 classes by Hermann Mauguin system of crystal notation, Study of $4/m\bar{3}m$ , $43m$ , $2/m\bar{3}$ , $4/m\bar{2}m$ , $6/m\bar{2}m$ , $622$ , $32$ , $2/m\bar{2}m$ , $2/m$ and 1 classes $32/m$ , Crystal imperfections.
Mineralogy - I	Structural classification of silicates, Physico-chemical and optical properties and occurrence of Silicate Mineral groups- Felspar, Felspathoid, Olivine, Garnet, Pyroxene, Amphibole, Mica and Silica groups
Mineralogy - II	Physico-chemical and optical properties and occurrence of Non-silicate mineral groups- Native elements, Oxides, Carbonates, Sulphides, Phosphates and Halides
Mineral optics	Snell's law, Isotropism and anisotropism, double refraction, birefringence, interference colour, interference figure (uniaxial and biaxial). Extinction angle, pleochroism, twinning, dispersion

**Objective:** to study the crystal structure, composition and optical properties of minerals for identification and characterization minerals, rocks and ores

**Outcome:**

A student of this course is required to demonstrate are indicated below:

- Develop skill in understanding the arrangement and bonding of atoms in minerals
- Geometric structure of crystal lattices
  
- Develop skill in handling and understanding the working of Petrological microscope and functions of its parts.
- Explain Nature of light rays and their propagation, internal reflection, double refraction, interference and polarization, and use of these optical properties in characterizing minerals.
- Understand and explain the knowhow of Preparation of thin section of minerals and rocks.
  - Describe the Behaviour of light in thin section and production of interference colours.
  - Identify and explain order of interference colour, twinkling, Optic axis, Uniaxial and biaxial minerals; Isotropism and anisotropism, Extinction and extinction angle; Pleochroism, pleochroic scheme, Birefringence

## 1AGLC2: Mineral Deposits

Broad Division	Detail syllabus	Credit	Marks
Processes of Formation	Processes of formation of mineral deposits- magmatic concentration, hydrothermal, sedimentary, residual and mechanical concentration, Oxidation and Supergene enrichment, syngenetic remobilization, submarine volcanic exhalation. Classification of mineral deposits, Controls of ore localization.	1	25
Ore deposits	Mineralogy, Mode of occurrence, Origin and Indian distribution of the following ore deposits-Iron, Manganese, Chromium, Copper, Lead and Zinc, Gold and Aluminium.	1	25
Industrial mineral deposits	Minerals/Rocks used in cement, refractories, ceramics and fertilizer industries. Mode of occurrence, Genesis and Indian distribution of the following Industrial minerals – Mica, Asbestos, Graphite, Gypsum. Important industrial mineral deposits of India, Precious and Semi precious minerals- types and characteristics	1	25
Fuel Geology	Coal and Petroleum – their characters, mode of occurrence, Genesis and Indian distribution, Important coal and petroleum deposits of India, Radioactive mineral deposits of India, Macroscopic and Microscopic constituent of coal , Coal bed methane	1	25

**Outcome:** A student of this course is required to demonstrate are indicated below:

- To know thoroughly about the important ore minerals with respect to their Mineralogy, mode of occurrence, origin, and uses.
- Learn about important ore deposits of India and their place of occurrences

Objective: to know the different processes that lead to ore deposits.

Outcome: enable the student understand processes so that better exploration and exploitation procedure can be adopted.

## 1AGLC3: Applied Economic Geology, Mineral economics and Remote Sensing.

<b>Applied Economic Geology, Mineral economics and Remote Sensing.</b>	Mineral Exploration: Principles, Geological exploration, Earth's gravity and magnetism, Geophysical exploration (Gravity, Magnetic, Electrical, seismic and radioactive), Geochemical exploration (path finder and indicator elements, dispersion patterns, geochemical anomaly, analytical methods and interpretation of soil, water, air, plant and rock and Geobotanical exploration. Mining Methods, Characters of ore minerals under reflected light.  Strategic, essential, critical minerals, renewable and non-renewable resources, National Mineral
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	<p>Policy, laws of sea, sustainable mineral development, sampling, assaying, ore reserve calculation</p> <p>Air-borne remote sensing: Concepts and principles of aerial photography, Aerial photographs - Types, Scale, Stereoscopy, Photo mosaics, Photo elements and photo interpretation</p> <p>Space – borne remote sensing : Principles, Sensors, Orbits, False colour composite, Interpretation of satellite imagery, Introduction to Digital image processing, Digital Elevation Model, Indian remote sensing satellites, Applications of remote sensing in landform and land use mapping, Structural mapping, Mineral and Groundwater exploration, Elementary ideas on Geographic Information System and Global Positioning System</p>
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Objective: to make the student understand different principles and practical methods that is followed for ore exploration and mining. Also, to understand different methods for calculating ore reserves.

To make the students know about the principle of aerial photography and remote sensing, concepts of EMR and interaction and basics of GPS and GIS

Outcome: A student of this course is required to demonstrate are indicated below

It will empower and skill the student for practical geological works in various organizations such as OMC Ltd., ONGC Ltd., Geological Survey of India etc.

To deal with various applications of remote sensing.

To interpret different types of maps

### **2AGLC1: Igneous petrology, Sedimentary petrology and Basin analysis:**

Broad Division	Detail syllabus
Igneous Petrology - I	Concept of magma and its generation. Silicate-melt equilibrium. Phase diagrams – Binary : Eutectic, Peritectic and solid solution and Ternary (Ab-An-Di) and (Ab-Or-Si) .Magmatic Differentiation, Assimilation, IUGS classification of igneous rocks
Igneous Petrology - II	Petrology and geotectonic evolution of granites, basalts, ophiolites, andesites and alkaline rocks. Petrology and Indian distribution of gabbro,

	kimberlite, anorthosites, carbonatites, lamprophyres
Sedimentary Petrology and Basin analysis - I	Texture of sedimentary rocks - size, sphericity, roundness and fabric of clastic grains and their significance. Structure of sedimentary rocks – mechanical, chemical and organic and their significance. Sedimentary basins – origin and classification of sedimentary basins in the light of geosynclinal and plate tectonics concepts. Classification of sedimentary rocks. Classification of sandstones and limestones.
Sedimentary Petrology and Basin analysis - II	Study of palaeocurrent and provenance. Sedimentary facies. Sedimentary environments and their classification; characteristic features of fluvial and marine environments, study of heavy minerals and their significance.

Objective: understanding the Igneous rocks that is how it is formed and classified and in what set up they are found.

To understand the important stratigraphic, structural and tectonic controls for the petroliferous basins of India

Outcome: empower the student to know different ores those are hosted by igneous rocks so that their exploration can be made.

The students with special papers having the subjects are preferred for job in the sectors of Oil and gas and BARC etc.

Thorough understanding of the subject will help the students to estimate the oil/gas or coal deposits with their grade.

**2AGLC2: Metamorphic petrology and Applied Geochemistry: 100 Marks & 4 Credits**

Broad Division	Detail syllabus
Metamorphic Petrology - I	Metamorphic fabrics, Mineralogical phase rule, Concept of zones, Facies and Grade in Metamorphism, Metamorphic Differentiation. Metasomatism, Granitisation, Classification of metamorphic rocks. ACF, AKF and AFM diagrams.
Metamorphic Petrology - II	Progressive metamorphism of argillaceous and calcareous sediments and basic igneous rocks. Ocean floor metamorphism, Cataclastic metamorphism. Paired metamorphic belts. Retrograde metamorphism, Petrology of important metamorphic rocks – Khondalites, Charnockites
Applied Geochemistry - I	Earth in relation to the solar system, Cosmic abundance of the elements. Structure and composition of the earth. Primary geochemical differentiation of the earth. Geochemical classification of elements, Isomorphism, Polymorphism, Atomic substitution

Applied Geochemistry - II	Geochemical cycle, Distribution of trace and rare earth elements in igneous rocks, Petrography of lunar rocks and meteorites, Introduction to Isotope Geochemistry
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Objective: understanding the metamorphic rocks that is how it is formed and classified and in what set up they are found.

To understand the chemical principles of earth systems

Outcome: empower the student to know different processes that lead to formation of metamorphic rocks.

The students will come to know about the compositional variation due to metamorphism

Describe metamorphic rocks, their mineral assemblages and texture.

Interpret metamorphic processes from evidence obtained from hand specimen and thin sections.

Describe the mechanism behind major geological systems.

### **2AGLC3: Applied hydrogeology and Engineering geology**

Broad Division	Detail syllabus
Applied Hydrogeology - I	Distribution of water on and within the Earth's surface; hydrologic cycle. Hydrologic properties of water bearing materials- Porosity, Permeability, Transmissibility, Storativity, specific yield and specific retention. Types of water bearing formations- Aquifers, Aquicludes, Aquitards and Aquifuge. Classification of aquifers.
Applied Hydrogeology - II	Darcy's law. Pumping tests and Interpretation of test data of simple aquifer situations- steady state flow of unconfined and confined aquifers. Groundwater provinces, Ground water exploration- Geological, Geophysical and remote sensing methods. Well drilling techniques. Quality of groundwater. Saline water intrusion in coastal aquifers
Engineering Geology - I	Site investigation techniques in engineering constructions. Engineering properties of rocks- Porosity, Density, hardness, compressive strength, Tensile strength, Shear strength, Modulus of deformation. Engineering properties of soils- Soil moisture, Grain size distribution and classification, Permeability, Shear strength, Deformation in soil. Earth quake resistant structures

Engineering Geology - II	Building materials (road metals, building stones, concrete aggregate). Landslides and stability of slopes. Geotechnical considerations in dams and reservoirs and their environmental impact. Tunnels and Bridges: their geological considerations. Geotechnical case studies of major dam projects- Bhakra, Koyna, Hirakud and Balimela
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**Objective:** To acquire knowledge and acquaint with Hydrologic Cycle, different hydrologic properties of water.

To have better understanding about aquifers and their types, different tests for ground water exploration

To acquire knowledge on suitable rocks as building materials and geotechnical considerations for site selection and feasibility study of construction of mega civil structures like dams, tunnels, bridges etc.

**Outcome:** A student of this course is required to demonstrate are indicated below:

- Know hydrologic properties of water bearing materials
- Interpret test data of simple aquifer situations
- Understand the Geological, Geophysical and remote sensing methods for groundwater exploration.
- and select suitable rocks for building materials based on their engineering properties
- Explain the engineering properties of rocks and soils.
- Find out and suggest the Geological considerations of Dam and reservoir site selection.
- Find out and suggest the Geological considerations of tunnel alignment, bridge site selection.
- Classify soil and describe the erosion process and conservation measures.
- Suggest Earthquake resistant structures

### **3AGLC1: Structural Geology, Geodynamics and Geomorphology**

Structural Geology – I	Stress ellipsoid, Stress trajectories, Strain ellipsoid, Homogeneous and inhomogeneous strain. Mechanism and factors of rock deformation. Planar and linear structures and their tectonic significance. Joints and their genetic types. Salt domes. Unconformities
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Structural Geology-II	Bases of fold classification. Classification of folds according to Fleuty, Ramsay and Turner-Weiss. Mechanism of folding. Superposition of folds. Classification faults, Anderson and Hafner theories of faulting. Recognition of faults in the field, Active faults and related topography
Geodynamics	Principles of Plate tectonics. Midoceanic ridges, Continental drift, Seafloor spreading, Island arcs, Geodynamics of the Indian sub-continent, Himalayan Orogeny.
Geomorphology	Geomorphic concepts and processes, Weathering and erosion, Erosion cycle, Theories of landform development. Coastal geomorphology. Geomorphology of India. Geomorphic mapping, Slope analysis, Drainage analysis.

**Objective:** To have knowledge on distribution and application of stress and strain in rock deformation along with Mechanism and factors of rock deformation.

To have complete understanding of geological Structures like Folds, Faults and Active faults along with their genesis and field applications

To have understanding of theories of plate tectonics and related features

To have adequate knowledge on different geomorphic processes and landform development.

**Outcome:** A student of this course is required to demonstrate are indicated below:

- Understand and apply concept of stress and strain; Strain ellipses of different types in rock deformations and their geological significances.
- Understand and explain the Mechanism and factors of rock deformation
- Learn the structural features like Planar and linear structures and their tectonic significance.
- Describe types, significance, recognition of unconformity in the field and map.
- Describe Salt domes and diapirs.
- Describe different structures and related topography
- Describe different geomorphic concepts and processes along with various landform development.
- Able to do geomorphic mapping, slope analysis from satellite data and topographic data.

### 3AGLC2: Paleontology, Applied Micropaleontology & Geological Oceanography

Broad Division	Detail syllabus
Palaeontology - I	Fossilization Processes (Taphonomy), Modes of preservation. Study of morphology, classification, evolution and extinction of Trilobites, Brachiopods. Lamellibranchs, Gastropods and Cephalopods
Palaeontology - II	Study of morphology, classification and evolution of Echinoids and Corals. Concept of evolution. Evolution of horse, elephant and man. Evolution and extinction of Dinosaurs; General study of fossil plants, Gondwana flora and its significance.
Applied Micropalaeontology	Types of microfossils, their separation and preparation for study. Application of microfossil study in different fields with special reference to study of biostratigraphy and petroleum exploration. Study of morphology, classification and ecology of foraminifers. Morphology of conodonts and ostracods, Palynology
Geological Oceanography	Scientific Ocean floor drilling and its major accomplishments; Temperature & Salinity distribution (Horizontal & Vertical) in Ocean waters; Dissolved gas in Sea water; Oxygen Minimum Zones and Upwelling in Oceans; Biological-Chemical-Physical interactions in Oceans; Surface & Deep Ocean Circulations

### 3AGLC3: Stratigraphy, Palaeogeography and Quarternary Geology

<b>Paleontology, Applied Micropaleontology &amp; Geological Oceanography</b>	<p>Principles of Stratigraphy, Stratigraphic correlation. Code of stratigraphic nomenclature, Concepts of Sequence-, magneto-, seismic- and chemo-stratigraphy. Precambrian stratigraphy of India-Distribution of Archaean. Cuddapah and Vindhyan Group and detailed study of type areas and other important groups (Delhi, Chhatisgarh and Kurnool).</p> <p>Distribution and detailed study of the type areas of Palaeozoic (Spiti and Kashmir), Mesozoic (Triassic of Spiti, Jurassic of Kutch and Cretaceous of Trichinopoly), Gondwana Supergroup :Associated flora &amp; its Significance</p> <p>Tertiary ( Assam), Siwalik Group, Deccantraps, Palaeoclimatic reconstruction, Paleogeography of India during Permo-carboniferous period, Triassic, Jurassic and Cretaceous Periods</p> <p>Global sea level rise – past and future, Paleoclimatic reconstruction, quaternary deposits and land forms of India. Quaternary dating methods; Radiocarbon, Uranium Series, argon isotope; Pleistocene glaciations – Causes and effects, OSL</p>
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**Objective: (A):** Understanding the basic evolutionary patterns, burial (taphonomic aspects) and the adaptabilities of species in various environmental settings.

**(B):** Process of formation of layers with the concept of temporal and spatial distribution, assemblages of fossils, minerals etc. Marine geosciences help to provide foundation in marine geology by examining the vast ocean floor, its geology, chemistry, physics and biology as they relate to the oceans.



**Outcome:** A student of this course is required to demonstrate are indicated below:

- A brief perception of process of earth which lead to mass extinction of flora and fauna
- Concept of evolutionary trends of various flora and fauna with respect to geological time till date
- Microfossils remain indispensable part of sedimentary basin study. The rise of paleoclimatology has given micropaleontology a new impetus that provide stable isotope and geochemical proxies for oceanographic and paleoenvironmental change.
- Radiometric dating methods and isotopic studies throw light on rate of evolution and environmental signatures from past.

**3AGLC4: Geostatistics and Computer application in Geology, Environmental geology, Medical Geology and Disaster management**

Unit	Broad Division	Detailed syllabus
I	Geostatistics and Computer application in Geology - II	Probability – concept, laws and application. Method of sampling. Frequency distribution and frequency tables. Graphical representation of frequency data - histogram, frequency curve and cumulative frequency curve. Graphical methods of determination of sample statistics - mean, standard deviation, skewness and kurtosis.
II	Geostatistics and Computer application in Geology - II	Normal frequency distribution. Degrees of freedom and level of significance. Correlation coefficient. The t-test – equality of sample means and significance of correlation coefficient. Regression analysis. Application of computer in solving statistical problems in geology.
III	Environmental geology and Medical geology	Renewable and Non-renewable resources, Conservation of mineral resources, environmental impacts of mining, mineral exploitation and their management, sustainable development of minerals, Management of solid wastes including mining wastes, Fly ash, Radioactive wastes; Environmental protection-Legislative measures in India Problems of Fluorosis and arsenic poisoning in India – Causes and remedial measures
IV	Disaster management	Disaster Management: Concepts, Earthquake , cyclones and tsunamis, floods, landslide and their management.

**Objective:** To have a understanding of basic of Geo statistical principles and its application in geological interpretation

To acquaint, aware and apply the geo-environmental issues related knowledge

To know To know the generalized concepts of disaster management and develop the skill to tackle the natural disasters as disaster managers

**Outcome:** A student of this course is required to demonstrate are indicated below:

- Describe the geological sampling methods, and representation of data in the fields like mining, sedimentary geology, biostratigraphy, hydrogeology etc.
- Describe the alternate energy resources its utilization in various sectors like domestic, industrial, mining etc.
- To deliberate the pollution issues, solid waste problems in the mining area.
- Describe different principles and practices of natural disaster management
- Application of disaster mitigation methods in real time occurrence
- Impart training and awareness to the public in the disaster vulnerable areas

#### **4th Semester**

#### **Elective A–Ore Geology 4AGLCE(A)**

#### **4AGLCE1(A): Ore Geology**

Ore genesis-A	Concept of mineral equilibria- homogenous and inhomogenous Thermodynamic principles in mineral formation Phase rule and its application, phase diagrams of binary (Fe-S and Cu-S) and ternary (Cu-Fe-S & Fe-Zn-s) systems. Eh – pH in natural environment; Eh-pH relationship with respect to iron and manganese in aqueous solution.
Ore genesis-B	Concepts of ore genesis: genesis related to magmatic, hydrothermal activity, SEDEX, residual, sedimentation, metamorphism, bacteriogenic activity

	Ore bearing fluids- nature, source, transportation, depositional environment in terms of ion potential and Fugacity. Chloride and sulphides complexes
	Geological thermometry, Fluid inclusion studies, ore deposits associated with plate boundaries.

**Objective:** To understand various Concepts of ore genesis

**Outcome:** A student of this course is required to demonstrate are indicated below:

- Detailed knowledge on different modern theories of ore genesis like magmatic, hydrothermal activity, SEDEX, residual, sedimentation, metamorphism, bacteriogenic activity
- Understand and application of Phase rule and its application, phase diagrams of binary (Fe-S and Cu-S) and ternary (Cu-Fe-S & Fe-Zn-s) systems. Eh – pH in natural environment; Eh-pH relationship with respect to iron and manganese in aqueous solution

**4AGLCE2(A): Ore Geology**

Ore deposits-A	Metallogenic epoch & province, Space and time distribution of ore deposits of India and World, Controls of ore localization, Classification of mineral deposit.
Ore deposits-B	Mineralogy, mode of occurrence, origin and Indian distribution of Fe, Mn, and Cr with special reference to Indian occurrences and growth of industries.
Ore Deposits-C	Mineralogy, mode of occurrence, origin and Indian distribution of Al, Cu, Pb & Zn with special reference to Indian occurrences and growth of industries.
Ore Deposits- D	Mineralogy, mode of occurrence, origin and Indian distribution of Ni, Sn, Au and Ag

**Objective:** To understand epochs and provinces, different controls of ore localization, various modes of occurrences, origin and Indian distribution of important ores

**Outcome:** A student of this course is required to demonstrate are indicated below:

- Detailed knowledge on different modern theories of ore genesis of Fe, Mn, Cr, Ni, Al, Au and Ag.
- Students will be exposed to various mines to understand the types of ore deposits.
- employability skills required for students will be enhanced.

**4AGLCE3(A): Ore Geology**

Unit	Broad Division	Detail syllabus
I	Exploration of Ore Deposits	Methods of surface and sub surface exploration- Geological, geophysical, geochemical and geobotanical Sampling, assaying, ore evaluation and reserve estimation. UNFC classification of reserves.
II	Mineral processing	Ore beneficiation, Ore beneficiation practicals as adepated in important Indian deposits, drilling, mining.
III	Mineral Management	National mineral policy, strategic, critical and essential minerals with special reference to India. Laws of sea. Management of mineral resources and sustainable mineral development.
IV	Mineral characterization	Ore textures and industrial application of ore microscopy. Propoties of ore minerals under ore microscope, microbalances, XRD and DTA analysis of minerals, paragenesis.

Objective: to make in depth study of ore exploration, beneficiation, and management and ore characterization.

Outcome: employability skills required for students are enhanced by this course