

# CHOICE BASED CREDIT SEMESTER SYSTEM

P.G. Syllabus  
M.Sc. Applied Geology



Department of Geology  
Utkal University  
Bhubaneswar

**UTKAL UNIVERSITY**  
**M.Sc. APPLIED GEOLOGY (EXAMINATION)**  
**SEMESTER CHOICE BASED CREDIT SYSTEM**

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**Examination Schedule** 1<sup>st</sup> Semester-December/January

2<sup>nd</sup> Semester-May/June

3<sup>rd</sup> Semester- December/January

4<sup>th</sup> Semester-May/June

1. Candidates with at least 2<sup>nd</sup> class honours in Geology are eligible to apply for admission in to the course. The course is of two years duration comprising four Semesters of Theory and practical. Each theory paper carries 100 marks out of which the internal marks will be 20% of the total that is 20 marks. The duration of the theory examination will be 3 hours. Practical papers will be of 100 marks and the duration of examination will be 6 hours.
2. The First Semester will start with the beginning of the academic session after the admission into the said course as per the University schedule.
3. Normally examination for First and Third Semesters will be completed between December-January and Examinations for Second and Fourth Semesters will be completed between May-June of the academic session. If for any reason(s) Semester Examinations could not be conducted as per schedule, both Semester (Theory and Practical) examinations of the session will be conducted at the end of the academic session of that year.
4. The Semester system of Examination will have internal valuation for theory papers. Practical papers will be examined by one internal examiner and one external examiner. If necessary the practical examination may be extended to the next day.
5. Seminar presentation in each academic session will carry 15 marks which will be taken into consideration in one Practical examination of the session. The seminar marks shall be given by three teachers of the department selected by The Teacher's Council at the beginning of the Semester. The marks shall be forwarded to the examiners (Internal and External) with the signature of all the three Teachers and counter signature of the Head of the Department at the time of Practical Examination.
6. In order to be eligible to appear the University Examination, attendance will be taken into account as per University Rules. The attendance will be calculated every month by the Department and the students are to collect information from the office.
7. A candidate, if so desires, will get one chance only to repeat in one or more paper(s) of any Semester with in a period of one year of the said Semester examination.
8. In the fourth Semester there will be Elective papers (A/B/C/D) out of which the students may choose any one out of the four Electives.
9. The practical paper 4AGLCE4 will carry 100 marks and corresponds to three theory papers. The Paper 4AGLCE5 is a project work (Industrial training / Dissertation work) carrying 100 marks.
10. If any student fails to complete the Project Report due to some on avoidable reasons, he/she may have to choose one of the Elective Theories in lieu of Project Report. The Theories are :

a) Mineral Resource Development

b) Environmental Science

11. In each Semester the students are required to undergo a Field Training programme for a period of 15 days. The students are to deposit a requisite fee towards the field training programme at the time of admission.

### Core paper (Compulsory)

#### 1st Semester

| Theory/<br>Practical | Paper No. | Title of the course  | Credit | Marks |
|----------------------|-----------|--|--------|-------|
| Theory               | 1AGLC1    | Crystallography, Mineralogy and Mineral optics                 | 4      | 100   |
| Theory               | 1AGLC2    | Mineral deposits   | 4      | 100   |
| Theory               | 1AGLC3    | Applied Economic Geology, Mineral economics and Remote Sensing | 4      | 100   |
| Practical            | 1AGLC4    | Practicals corresponding to Theory Paper 1AGLC1                | 6      | 100   |
| Practical            | 1AGLC5    | Practicals corresponding to Theory Paper 1AGLC2 and 1AGLC3     | 6      | 100   |
|                      |           | Total  | 24     | 500   |

#### 2nd Semester

| Theory/<br>Practical | Paper No. | Title of the course  | Credit | Marks |
|----------------------|-----------|--|--------|-------|
| Theory               | 2AGLC1    | Igneous petrology, Sedimentary petrology and Basin analysis              | 4      | 100   |
| Theory               | 2AGLC2    | Metamorphic petrology and Applied Geochemistry                           | 4      | 100   |
| Theory               | 2AGLC3    | Applied hydrogeology and Engineering geology                             | 4      | 100   |
| Practical            | 2AGLC4    | Practicals corresponding to Theory Paper 2AGLC1, Seminar                 | 6      | 100   |
| Practical            | 2AGLC5    | Practicals corresponding to Theory Paper 2AGLC2 and 2AGLC3, Field report | 6      | 100   |
|                      |           | Total  | 24     | 500   |

#### 3rd Semester

| Theory/<br>Practical | Paper No. | Title of the course   | Credit | Marks |
|----------------------|-----------|---|--------|-------|
| Theory               | 3AGLC1    | Structural geology, Geodynamics and Geomorphology                 | 4      | 100   |
| Theory               | 3AGLC2    | Paleontology, Applied Micropaleontology & Geological Oceanography | 4      | 100   |
| Theory               | 3AGLC3    | Stratigraphy, Palaeogeography and                                 | 4      | 100   |

|           |        |   |     |       |
|-----------|--------|---|-----|-------|
|           |        | Quaternary Geology  |     |       |
| Theory    | 3AGLC4 | a) Geostatistics and Computer application in Geology<br>b) Environmental geology, Medical geology and Disaster management | 2+2 | 50+50 |
| Practical | 3AGLC5 | Practicals corresponding to Theory Papers   | 6   | 100   |
|           |        | Total   | 22  | 500   |

#### **4th Semester**

#### **Core Elective papers (Special papers)**

| Theory/<br>Practical | Paper No. | Title of the course   | Credit | Marks |
|----------------------|-----------|---|--------|-------|
| Theory               | 4AGLCE1   | <b>Elective A/B/C/D</b>   | 4      | 100   |
| Theory               | 4AGLCE2   | <b>Elective A/B/C/D</b>   | 4      | 100   |
| Theory               | 4AGLCE3   | <b>Elective A/B/C/D</b>   | 4      | 100   |
| Practical            | 4AGLCE4   | Practicals corresponding to Theory Paper 4AGLCE1 and 4AGLCE2, Seminar, Field report | 6      | 100   |
| Project              | 4AGLCE5   | Project/Dissertation (external /Internal)   | 6      | 100   |
|                      |           | Total   | 24     | 500   |

**Elective A** : Ore Geology

**Elective B** : Applied Hydrogeology and Water Management

**Elective C** : Fuel Geology and Sedimentary Petrology

**Elective D** : Remote Sensing and GIS

The students opting for core elective on any one of the subjects A/B/C/D have to prepare a project on the basis of the work done in the field/laboratory for at least 2 weeks. The concerned student has to present his/her findings before the Teachers council and shall be evaluated by the Board of three internal examiners appointed by the Board of studies / Vice Chancellor. The viva shall be held by an external examiner appointed by the Board of Studies / Vice Chancellor.

The distribution of marks is as follows:

1. Report writing : 40
2. Presentation : 30
3. Viva Voce : 30

## DETAILED SYLLABUS

### 1st semester

#### **1AGLC1: Crystallography, Mineralogy and Mineral optics: 100 Marks & 4 Credits**

| Unit | Broad Division  | Detail syllabus  | Credit | Marks |
|------|-----------------|--|--------|-------|
| I    | 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 3/m, 4 3m, 2/m 3, 4/m 2/m 2/m, 6/m 2/m 2/m 6 2 2, 32 2/m 2/m 2/m, 2/m and 1 classes 3 2/m,, Crystal imperfections. | 1      | 25    |
| II   | 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  | 1      | 25    |
| III  | Mineralogy - II | Physico-chemical and optical properties and occurrence of Non-silicate mineral groups- Native elements, Oxides, Carbonates, Sulphides, Phosphates and Halides  | 1      | 25    |
| IV   | Mineral optics  | Snell's law, Isotropism and anisotropism, double refraction, birefringence, interference colour, interference figure (uniaxial and biaxial). Extinction angle, pleochroism, twinning, dispersion   | 1      | 25    |

#### **1AGLC2: Mineral Deposits: 100 Marks & 4 Credits**

| Unit | Broad Division              | Detail syllabus  | Credit | Marks |
|------|-----------------------------|--|--------|-------|
| I    | 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    |
| II   | 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    |
| III  | 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    |
| IV   | 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    |

#### **1AGLC3: Applied Economic Geology, Mineral economics and Remote Sensing: 100 Marks & 4 Credits**

| Unit | Broad Division                | Detail syllabus  | Credit | Marks |
|------|-------------------------------|--|--------|-------|
| I    | Applied Economic Geology - I  | 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, | 1      | 25    |
| II   | Applied Economic Geology - II | Strategic, essential, critical minerals, renewable and non-renewable resources, National Mineral Policy, laws of sea, sustainable mineral development, sampling, assaying, ore reserve calculation   | 1      | 25    |
| III  | Remote Sensing - I            | Air-borne remote sensing: Concepts and principles of aerial photography, Aerial photographs - Types, Scale, Stereoscopy, Photo mosaics, Photo elements and photo interpretation  | 1      | 25    |
| IV   | Remote Sensing - II           | 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                    | 1      | 25    |

**1AGLC4: Practicals corresponding to Theory Paper 1AGLC1: 100 Marks & 6 Credits**

| Broad Division  | Detailed syllabus   | Marks |
|-----------------|---|-------|
| Crystallography | Identification of crystal models as per theory, Stereographic Projection of crystals, Axial ratio determination.  | 20    |
| Mineralogy      | Megascopeic and Microscopic identification of rock forming minerals   | 40    |
| Mineral optics  | Determination of sign of elongation, Extinction angle, scheme of pleochroism, Order of interference colours, Optic sign determination by interference figure. | 20    |
| Others          | Lab. Records and viva voce  | 10+10 |

**1AGLC5: Practicals corresponding to Theory Paper 1AGLC2 and 1AGLC3: 100 Marks & 6 Credits**

| Broad Division              | Detailed syllabus  | Marks |
|-----------------------------|--|-------|
| Metallic deposits           | Megascopeic identification of metallic minerals, Microscopic identification of ore minerals and their textures | 30    |
| Industrial mineral deposits | Megascopeic identification of nonmetallic minerals, Calculation of assay value and reserve                     | 30    |
| Remote Sensing              | Study and Interpretation of Aerial photo and Satellite Imageries; Mapping with GPS.                            | 20    |
| Others                      | Laboratory records and Viva voce   | 20    |

**2nd semester****2AGLC1: Igneous petrology, Sedimentary petrology and Basin analysis: 100 Marks & 4 Credits**

| Unit | Broad Division                                | Detail syllabus   | Credit | Marks |
|------|---|---|--------|-------|
| I    | 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   | 1      | 25    |
| II   | 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   | 1      | 25    |
| III  | 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. | 1      | 25    |
| IV   | 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.   | 1      | 25    |

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

| Unit | Broad Division             | Detail syllabus  | Credit | Marks |
|------|----------------------------|--|--------|-------|
| I    | 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.  | 1      | 25    |
| II   | 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 | 1      | 25    |
| III  | 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              | 1      | 25    |
| IV   | 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   | 1      | 25    |

**2AGLC3: Applied hydrogeology and Engineering geology: 100 Marks & 4 Credits**

| Unit | Broad Division            | Detail syllabus   | Credit | Marks |
|------|---------------------------|---|--------|-------|
| I    | 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.   | 1      | 25    |
| II   | 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   | 1      | 25    |
| III  | 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 | 1      | 25    |
| IV   | 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  | 1      | 25    |

**2AGLC4: Practicals corresponding to Theory Paper 2AGLC1, Seminar: 100 Marks & 6 Credits**

| Broad Division                           | Detailed syllabus  | Marks |
|--|--|-------|
| Igneous Petrology                        | Megascope and microscopic petrography of igneous rocks, calculation of norm and Niggli values.   | 30    |
| Sedimentary petrology and Basin analysis | Megascope and microscopic petrography of sedimentary rocks. Drawing of histogram, frequency curve and cumulative frequency curve. Determination of mean, standard deviation, skewness, kurtosis by graphical methods.  | 35    |
| Seminar                                  | Seminar marks shall be given by 3 teachers of the department selected by the Teachers Council at the beginning of the Semester. The mark shall be forwarded to the examiners (Internal and External) with the signature of all the three teachers with countersignature of the Head of the Department at the time of the Practical examination | 15    |
| Others                                   | Laboratory records and viva voce   | 20    |

**2AGLC5: Practicals corresponding to Theory Paper 2AGLC2 and 2AGLC3, Field report: 100 Marks & 6 Credits**

| Broad Division        | Detailed syllabus  | Marks |
|-----------------------|--|-------|
| Metamorphic petrology | Megascope and microscopic petrography of metamorphic rocks. ACF, AKF and AFM diagrams.   | 25    |
| Geochemistry          | Calculation of mineral formulae from chemical data   | 10    |
| Hydrogeology          | Analysis of Resistivity survey data, analysis and interpretation of bore hole logs. Water table contour maps, Determination of pH, conductance, total hardness of water samples, | 20    |
| Engineering Geology   | Soil study, Geological problems in dams, Tunnels and Bridges. Engineering properties of rocks  | 15    |
| Field report          | Results of the field investigation to be submitted in form of a report   | 15    |
| Others                | Laboratory records and viva voce   | 15    |

### **3rd Semester**

#### **3AGLC1: Structural geology, Geodynamics and Geomorphology: 100 Marks & 4 Credits**

| Unit | Broad Division         | Detail syllabus   | Credit | Marks |
|------|------------------------|---|--------|-------|
| I    | 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                          | 1      | 25    |
| II   | 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 | 1      | 25    |
| III  | Geodynamics            | Principles of Plate tectonics. Midoceanic ridges, Continental drift, Seafloor spreading, Island arcs, Geodynamics of the Indian sub-continent, Himalayan Orogeny.   | 1      | 25    |
| IV   | 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.   | 1      | 25    |

#### **3AGLC2: Paleontology, Applied Micropaleontology & Geological Oceanography: 100 marks & 4 Credits**

| Unit | Broad Division             | Detail syllabus  | Credit | Marks |
|------|----------------------------|--|--------|-------|
| I    | Palaeontology - I          | Fossilization Processes (Taphonomy), Modes of preservation. Study of morphology, classification, evolution and extinction of Trilobites, Brachiopods. Lamellibranchs, Gastropods and Cephalopods   | 1      | 25    |
| II   | 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.   | 1      | 25    |
| III  | 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 | 1      | 25    |
| IV   | 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             | 1      | 25    |

#### **3AGLC3: Stratigraphy, Palaeogeography and Quarternary Geology: 100 Marks & 4 Credits**

| Unit | Broad Division                   | Detail syllabus  | Credit | Marks |
|------|----------------------------------|--|--------|-------|
| I    | Stratigraphy - I                 | 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). | 1      | 25    |
| II   | Stratigraphy - II                | 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 & its Significance  | 1      | 25    |
| III  | Stratigraphy and Palaeogeography | Tertiary ( Assam), Siwalik Group, Deccantraps, Palaeoclimatic reconstruction, Paleogeography of India during Permo-carboniferous period, Triassic, Jurassic and Cretaceous Periods   | 1      | 25    |
| IV   | Quaternary Geology               | 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   | 1      | 25    |



**3AGLC4: Geostatistics and Computer application in Geology, Environmental geology,  
Medical Geology and Disaster management: 100 Marks & 4 Credits**

| Unit | Broad Division   | Detailed syllabus  | Credit | Marks |
|------|--|--|--------|-------|
| 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.   | 1      | 25    |
| 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.  | 1      | 25    |
| 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<br>Problems of Fluorosis and arsenic poisoning in India – Causes and remedial measures | 1      | 25    |
| IV   | Disaster management                                    | Disaster Management: Concepts, Earthquake , cyclones and tsunamis, floods, landslide and their management.   | 1      | 25    |

**3AGLC5: Practicals corresponding to Theory Papers: 100 Marks & 6 Credits**

| Broad Division                 | Detailed syllabus  | Marks |
|--------------------------------|--|-------|
| Structural Geology             | Completion of outcrops. Interpretation of geological maps. Structural problems – thickness and depth of strata, three-point problem, determination of true and apparent dips. Stereographic projection – $\pi$ and $\beta$ diagrams. Plotting of line and planes, problems relating to true and apparent dips, plunge and pitch, angle between planes and lines. | 25    |
| Geomorphology and Geotectonics | Contouring of land forms, Toposheet studies, Slope and drainage analysis, Morphometric analysis  | 10    |
| Palaeontology                  | Identification of animal and plant fossils as stated above. Graphic representation of their stratigraphic interval. Arrangement of fossils in chronological order. Drawing and labeling of fossils   | 25    |
| Stratigraphy                   | Stratigraphic assemblages – Identification and interpretation  | 10    |
| Geostatistics                  | Related to the corresponding theory  | 15    |
| Others                         | Laboratory records and Viva voce   | 15    |

**4th Semester**

**Elective A–Ore Geology 4AGLCE(A)**

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

| Unit | Broad Division | Detail syllabus   | Credit | Marks |
|------|----------------|---|--------|-------|
| I    | Ore genesis-A  | Concept of mineral equilibria- homogenous and inhomogenous<br>Thermodynamic principles in mineral formation<br>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. | 1      | 25    |
| II   | Ore genesis-B  | Concepts of ore genesis: genesis related to magmatic, hydrothermal activity, SEDEX, residual, sedimentation, metamorphism, bacteriogenic activity   | 1      | 25    |
| III  | Ore genesis- C | Ore bearing fluids- nature, source, transportation, depositional environment in terms of ion potential and Fugacity. Chloride and sulphides complexes   | 1      | 25    |
| IV   | Ore genesis-D  | Geological thermometry, Fluid inclusion studies, ore deposits associated with plate boundaries.   | 1      | 25    |

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

| Unit | Broad Division  | Detail syllabus   | Credit | Marks |
|------|-----------------|---|--------|-------|
| I    | 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. | 1      | 25    |
| II   | 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.         | 1      | 25    |
| III  | 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.        | 1      | 25    |
| IV   | Ore Deposits- D | Mineralogy, mode of occurrence, origin and Indian distribution of Ni, Sn, Au and Ag   | 1      | 25    |

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

| Unit | Broad Division              | Detail syllabus   | Credit | Marks |
|------|-----------------------------|---|--------|-------|
| 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. | 1      | 25    |
| II   | Mineral processing          | Ore beneficiation, Ore beneficiation practices adopted in Fe, Mn, Al, Cr ore deposits, drilling, mining.  | 1      | 25    |
| 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.            | 1      | 25    |
| IV   | Mineral characterization    | Ore textures and industrial application of ore microscopy. Properties of ore minerals under ore microscope, paragenesis and zoning.   | 1      | 25    |

**4AGLCE4(A): Ore Geology (Practical)**

|                          |  |   |    |
|--------------------------|--|---|----|
| Related to Theory Papers | Chemical analysis of ores- Fe, Mn, Cu.<br>Mineralographic examination of ore minerals and etch test. Megascopic identification of oreassemblages. Genetic and paragenetic interpretation from megascopic examination of ore assemblages. Reserve calculation and assay problems. Study of X-raydiffractogram for mineral identification. Lab. Record, Field report and Viva voce | 6 | 85 |
|                          | Seminar  |   | 15 |

**4AGLCE5(A): Ore Geology (Project)**

|              |                |   |    |
|--------------|----------------|---|----|
| Project work | Report writing | 6 | 40 |
|              | Presentation   |   | 30 |
|              | Viva Voce      |   | 30 |

**Elective B– Applied Hydrogeology and Water Management 4AGLCE(B)****4AGLCE1(B): Applied Hydrogeology and Water Management**

| Unit | Broad Division                           | Detail syllabus   | Credit | Marks |
|------|--|---|--------|-------|
| I    | Occurrence of groundwater                | Occurrence of groundwater-vertical zonation Geological formations, Aquifers, springs and Thermal springs. Origin of groundwater, Groundwater basins; Aquifer types components of hydrologic Cycle, Hydrometeorology, Hydrographs.   | 1      | 25    |
| II   | Hydrogeological properties               | Groundwater properties based on storage and movement, porosity and permeability, Darcy's law, Transmissibility, specific yield, specific retention, storage coefficient, specific capacity of wells. Field and laboratory determination of porosity and hydraulic conductivity. | 1      | 25    |
| III  | Groundwater Occurrences in various rocks | Groundwater condition in rock types crystalline - volcanic, Carbonate, lithified sediments, fluvial deposits, coastal and aeolian deposits. Groundwater levels and its fluctuation, water table contour maps. Elementary idea on barometric and tidal efficiencies.             | 1      | 25    |
| IV   | Groundwater provinces                    | Groundwater in different rocks and geomorphic terrain. Groundwater provinces of India and Odisha. Thermal springs of Odisha. Hydrology of arid zone and coastal zones of India.   | 1      | 25    |

**4AGLCE2(B): Applied Hydrogeology and Water Management**

| Unit | Broad Division                       | Detail syllabus   | Credit | Marks |
|------|--------------------------------------|---|--------|-------|
| I    | Well hydrolics-I                     | Design and construction of wells, yield tests and selection of pumpsets. Maintenance and development of wells.  | 1      | 25    |
| II   | Well hydrolics-II                    | Unidirectional and radial flow of groundwater, general groundwater flow equations, pumping test, steady and unsteady flow, Theis, Theim, Jacobs and Walton's equations. | 1      | 25    |
| III  | Groundwater extraction and problems  | Groundwater problems related to foundation work, canals, Mining and tunnels. Problems of over-exploitation, artificial recharge and rain water harvesting.              | 1      | 25    |
| IV   | Groundwater resources and management | Groundwater estimation, Groundwater budgeting, groundwater balance, groundwater Legislation. Management of coastal aquifers of Odisha.                                  | 1      | 25    |

**4AGLCE3(B): Applied Hydrogeology and Water Management**

| Unit | Broad Division               | Detail syllabus   | Credit | Marks |
|------|------------------------------|---|--------|-------|
| I    | Groundwater quality          | Quality of groundwater, Reporting of groundwater quality data, Maps and diagrams, Groundwater pollution, Suitability of groundwater for various uses, Fluoride problem in Odisha. Fluoride and Arsenic problems in India.                             | 1      | 25    |
| II   | Groundwater basin management | Groundwater basin management and conjunctive use, saline water intrusion into coastal aquifers.   | 1      | 25    |
| III  | Groundwater exploration      | Groundwater exploration:- Geological, Geophysical and remote sensing methods, preparation of hydrogeomorphic and lineament maps and their role in interpretation of groundwater.  | 1      | 25    |
| IV   | Pollution of groundwater     | Surface water and ground water pollution and their treatment, Environmental impact of groundwater pollution and extraction of groundwater. Diseases due to various chemical constituents & trace metals in groundwater and their mitigation measures. | 1      | 25    |

**4AGLCE4(B): Applied Hydrogeology and Water Management (Practical)**

|  |   |    |
|--|---|----|
| Determination of pH, conductance, turbidity, IDS, D.O., acidity alkalinity, Ca, Mg, Fluoride, bicarbonate, TH., Determination of porosity and permeability. Data interpretation of resistivity survey. Chemical data plotting, water table contour maps. Numerical problems related to various hydrologic properties. Hydrogeological interpretation by Remote Sensing method. | 6 | 85 |
| Seminar  |   | 15 |

**4AGLCE5(B): Applied Hydrogeology and Water Management (Project)**

|              |                |   |    |
|--------------|----------------|---|----|
| Project work | Report writing | 6 | 40 |
|              | Presentation   |   | 30 |
|              | Viva Voce      |   | 30 |

**Elective C: Fuel Geology and Sedimentary Petrology**  
**4AGLCE1(C): Fuel Geology and Sedimentary Petrology**

| Unit | Broad Division     | Detail syllabus  | Credit | Marks |
|------|--------------------|--|--------|-------|
| I    | Coal Geology - I   | Types of coal, Origin of coal, composition of coal (chemical and maceral composition), coal as plant debris-Lignin, protein, fats, wax etc. ,genetic relationship of plant constituents H/C Vr.O/C diagram. Methods of coal mining.  | 1      | 25    |
| II   | Coal Geology - II  | Coal petrography and its application in carbonization and hydrogenation (Liquefaction). Fires in underground mines and combating methods. Environmental pollution due to coal mining.  | 1      | 25    |
| III  | Coal Geology - III | Behavior of coal on heating-DTA and Differential Thermo gravimetric (DTG) analysis, plasticity measurement, Infrared analysis, Crossing point temperature analysis of coal, Spontaneous combustion of coals- mechanism and preventive measures.                              | 1      | 25    |
| IV   | Coal Geology - IV  | Geological geographical distribution of Indian coal fields, Study of important coal and lignite deposits of India: Gondwana coal fields: Jharia, Raniganj, Talchir and Ib valley coalfields, Tertiary coalfields: Coalfields of Assam & Meghalaya, Neyveli lignite deposits. | 1      | 25    |

**4AGLCE2(C): Fuel Geology and Sedimentary Petrology**

| Unit | Broad Division       | Detail syllabus   | Credit | Marks |
|------|----------------------|---|--------|-------|
| I    | Petroleum Geology-I  | Origin, migration and entrapment of Petroleum, Characteristics of source and reservoir rocks, structural, stratigraphic and combination traps, Techniques of Petroleum exploration.   | 1      | 25    |
| II   | Petroleum Geology-II | Geographical and geological distribution of oil and natural gas in India, Study of important Onshore and offshore petroliferous basins: Assam oil fields, Cambay basin, Krishna-Godavari basin, Cauvery basin and Bombay High.  | 1      | 25    |
| III  | Nuclear Geology-I    | Mineralogy and Geochemistry of radioactive minerals, Instrumental techniques of detection and measurement of radioactivity, Radioactive methods of exploration, Utilization of radioisotopes.   | 1      | 25    |
| IV   | Nuclear Geology-II   | Classification of Uranium deposits, Thorium resources of India. Challenges and Prospects of Uranium Industry, Study of important radioactive minerals deposits in India with respect to mineralogy, mode of occurrence and origin, Beneficiation methods, Radioactive waste management. | 1      | 25    |

**4AGLCE3(C): Fuel Geology and Sedimentary Petrology**

| Unit | Broad Division              | Detail syllabus   | Credit | Marks |
|------|-----------------------------|---|--------|-------|
| I    | Sedimentary Petrology - I   | Field techniques for study of Sedimentary Rocks- Mapping, palaeocurrent data collection and analysis, study of sedimentary structures, palaeo-hydraulics, interpretation of fluvial channels.   | 1      | 25    |
| II   | Sedimentary Petrology - II  | Study of sedimentary textures and their geological significance, Heavy mineral analysis and significance, sub-surface correlation of sedimentary deposits,  | 1      | 25    |
| III  | Sedimentary Petrology - III | Preparation of Isopach and Facies maps, Sequence stratigraphy, Methods of sediment transportation by water, estimation of bed load and suspension load. Basin classification and description, sedimentary basins formation - concepts.Sedimentary basins of India | 1      | 25    |
| IV   | Sedimentary Petrology - IV  | Characteristics of provenance, classification of Sandstone, limestone, conglomerate, Sedimentary environment and facies, Walther's Law  | 1      | 25    |

**4AGLCE4(C): Fuel Geology and Sedimentary Petrology (Practical)**

|                    |   |    |
|--------------------|---|----|
| Practical subjects | Megascope and microscopic petrography of sedimentary rocks. Rock assemblage and their environmental interpretation. Modal analysis. Size analysis, Heavy mineral analysis, Palaeocurrent analysis. Preparation of isopach maps, lithofacies maps. Construction of vertical sections showing sedimentary cycles and their correlations.<br>Megascope and microscopic study of coals. Proximate analysis of coals. Coal petrography, Problems related to coal and petroleum | 85 |
|                    | Seminar   | 15 |

**4AGLCE5(C): Fuel Geology and Sedimentary Petrology (Project)**

|              |                |   |    |
|--------------|----------------|---|----|
| Project work | Report writing | 6 | 40 |
|              | Presentation   |   | 30 |
|              | Viva Voce      |   | 30 |

**Elective D Remote Sensing and GIS**  
**4AGLCE1(D): Remote Sensing and GIS**

| Unit | Broad Division                    | Detail syllabus  | Credit | Marks |
|------|-----------------------------------|--|--------|-------|
| I    | Principles of Remote Sensing - I  | History of remote sensing, Benefits of remote sensing over conventional methods of resource survey, components of remote sensing system, Global and Indian remote sensing satellites. Electromagnetic radiation(EMR), Spectral bands, Atmospheric interactions with EMR, Interactions of EMR with Earth's surface materials- rocks, minerals, soils, water, vegetation . | 1      | 25    |
| II   | Principles of Remote Sensing - II | Remote sensing platforms- types and uses. Sensors-fundamental properties and functions. Sensor parameters- spatial, spectral, temporal and radiometric resolution, types of sensors and basic features of different types of sensors in different satellites- Landsat, SPOT, IRS etc.  | 1      | 25    |
| III  | Aerial Remote Sensing -I          | Basic requirements of aerial photography, planning for photography, Factors influencing image quality, Aerial cameras, Flight direction, Flying height, Forward and lateral overlaps, Time of photography, Information recorded on aerial photographs, preparation of photo index, Aerial mosaics.   | 1      | 25    |
| IV   | Aerial Remote Sensing -II         | Principles of aerial photography, types of aerial photographs, characteristics features of aerial photography- scale, vertical exaggeration, drift and crab.   | 1      | 25    |

**4AGLCE2(D): Remote Sensing and GIS**

| Unit | Broad Division                            | Detail syllabus  | Credit | Marks |
|------|---|--|--------|-------|
| I    | Photogrammetry                            | Geometry of Aerial photographs, Stereoscopic parallax, Measuring instruments-parallax bar & its use. Stereoscopy, Pseudoscopy, stereoscopic exaggeration, Estimation of slope and dip.   | 1      | 25    |
| II   | Aerial Photointerpretation- Techniques    | Photo elements, visual image interpretation- general procedure, interpretation of aerial photograph and satellite imagery, false colour composite (FCC), stereoscopes, conditions for stereoscopic vision, digital image processing.   | 1      | 25    |
| III  | Aerial Photointerpretation- Geomorphology | Basic concepts of geomorphology, climatic influence on geomorphic process, Geomorphic cycles: Fluvial, Arid, Glacial, coastal and volcanic. Interpretation of various landforms, Structural and tectonic landforms.  | 1      | 25    |
| IV   | Aerial Photointerpretations - Geology     | Geotechnical analysis, Vegetation analysis, Landuse analysis, Landform analysis, Drainage analysis, Convergence of evidence, Lithological interpretation of Igneous, Sedimentary and Metamorphic rock, interpretation of structural features – folds, faults and unconformity. | 1      | 25    |

**4AGLCE3(D): Remote Sensing and GIS**

| Unit | Broad Division                 | Detail syllabus   | Credit | Marks |
|------|--------------------------------|---|--------|-------|
| I    | Remote Sensing Application I   | Application of remote sensing techniques in geological and geomorphological mapping, landuse and landcover studies, terrain evaluation, mineral exploration and groundwater resources evaluation, petroleum exploration   | 1      | 25    |
| II   | Remote Sensing Application II  | Application of remote sensing techniques in agricultural management, forest mapping and management, irrigation and watershed management, engineering site evaluation for dam, reservoir, tunnel and highways  | 1      | 25    |
| III  | Remote Sensing Application III | Application of remote sensing in environmental hazard managements- floods, landslide and coastal erosion, soil mapping, waste land mapping, sustainable development studies   | 1      | 25    |
| IV   | GIS and GPS                    | Fundamentals of geographic information system (GIS), data structure of GIS, Raster and vector data, Representation of geographical entities by raster and vector methods. Application of GIS in various fields of geology. Elementary knowledge on Global Positioning System(GPS) | 1      | 25    |

**4AGLCE4(D): Remote Sensing and GIS (Practical) 6 credits and 100 marks**

|                    |  |    |
|--------------------|--|----|
| Practical subjects | Marking of principal points. Determination of scale. Tracing of details from aerial photos and imageries. Stereoscopic test, Use of pocket and mirror stereoscopes, use of parallax bar. Measurement of heights and determination of slopes from photos. Estimation of dip of beds. Study of topographic maps to identify typical landforms. Preparation of geologic, geomorphic and land use maps from aerial photos and imageries. Characterisation of typical geologic formations of Odisha i.e. alluvial deposits, laterite deposits, Eastern Ghats, Gondwana rocks etc. Lab. Records, Field reports/Project report and viva-voce. | 85 |
|                    | Seminar  | 15 |

**4AGLCE5(D): Fuel Geology and Sedimentary Petrology (Project)**

|              |                |   |    |
|--------------|----------------|---|----|
| Project work | Report writing | 6 | 40 |
|              | Presentation   |   | 30 |
|              | Viva Voce      |   | 30 |

## **ALLIED ELECTIVES**

(Open to students of the Dept. as well as of Allied disciplines)

|   |         |                             |          |           |
|---|---------|-----------------------------|----------|-----------|
| 1 | 3AGLAE1 | Mineral resources of Odisha | Credit 4 | Marks 100 |
| 2 | 3AGLAE2 | Stratigraphy of India       | Credit 4 | Marks 100 |

### **3AGLAE1 - Mineral Resources of Odisha – 4CH – 100 Marks**

| Unit       | Title of the course   |
|------------|---|
| Unit – I   | Mineral wealth of Odisha – Identifying characteristics of minerals  |
| Unit – II  | Process of Formation – Magmatic concentration, Hydrothermal deposits, Oxidation and Supergene enrichment, Residual concentration. |
| Unit – III | Use and distribution of Iron ore, Manganese ore, Chromite, Bauxite, Coal, Platinum  |
| Unit – IV  | Construction materials, Limestone, Gem occurrence of Odisha, Beach sand deposits  |

### **3AGLAE2 – Stratigraphy – 4CH – 100 Marks**

| Unit       | Title of the course   |
|------------|---|
| Unit – I   | Geological time scale, definition of Stratigraphy, Principle of stratigraphy      |
| Unit – II  | Precambrian Stratigraphy of India-Cudapah, Vindhyan and Dharwar Supergroup        |
| Unit – III | Paleozoic Stratigraphy-Study of Paleozoic (Spiti of Kashmir), Gondwana Supergroup |
| Unit – IV  | Stratigraphy of Odisha  |

## **FREE ELECTIVES**

(Open to students of all departments)

|    |          |                            |          |           |
|----|----------|----------------------------|----------|-----------|
| 1. | 3AGLFE 1 | Disaster management        | Credit 4 | Marks 100 |
| 2. | 3AGLFE 2 | Mineral resources of India | Credit 4 | Marks 100 |
| 3. | 3AGLFE 3 | Geo-environmental Studies  | Credit 4 | Marks 100 |

### **3AGLFE 1 - Disaster Management – 4CH – 100 Marks**

| Unit       | Title of the course   |
|------------|---|
| Unit – I   | Introduction to disaster, type of disasters: natural, man made technologies |
| Unit – II  | Concept of Disaster management, pre, relative & post disaster management    |
| Unit – III | Flood, cyclone, drought, landslide.   |
| Unit – IV  | Earthquake, Tsunami, heat wave, cold wave                                   |

### **3AGLFE 2 - Mineral Resources of India– 4CH – 100 Marks**

| Unit       | Title of the course   |
|------------|---|
| Unit – I   | Mineral wealth of Odisha – Identifying characteristics of minerals  |
| Unit – II  | Process of Formation – Magmatic concentration, Hydrothermal deposits, Oxidation and Supergene enrichment, Residual concentration. |
| Unit – III | Use and distribution of Iron ore, Manganese ore, Chromite, Bauxite, Coal, Platinum  |
| Unit – IV  | Construction materials, Limestone, Gem occurrence of Odisha, Beach sand deposits  |

### **3AGLFE 3 - Geo-environmental studies– 4CH – 100 Marks**

| Unit       | Title of the course  |
|------------|--|
| Unit – I   | Impact of mining on environment (water, soil and air), Acid mine drainage  |
| Unit – II  | Global warming, Sea level rise, Green House Gases, Ozone depletion, Acid rain  |
| Unit – III | Solid wastes and their management, Liquid waste and its management   |
| Unit – IV  | Hydrologic cycle, Vertical distribution of ground water, water pollution-Surface and sub surface; cause and management |