

**COURSES OF STUDIES  
FOR  
M.Sc EXAMINATION  
(with effective from 2023-24)**

**GEOLOGY  
(Semester System)**

**DEPARTMENT OF GEOLOGY  
DHARANIDHAR UNIVESITY ,KEONJHAR**

**[Structural Organisation of M.Sc. syllabus]**

**FIRST SEMESTER**

Course Code	Title of the paper	Credits	Max. Marks		Total
			End-Sem.	Mid-Sem.	
GEO-CC -101	Igneous Petrology & Geochemistry	04	80	20	100
GEO-CC -102	Sedimentary Petrology	04	80	20	100
GEO-CC -103	Metamorphic Petrology	04	80	20	100
GEO-CC -104	Earth System Sciences and Remote Sensing	04	80	20	100
GEO-P-105	Practical Covering CC101,CC102 and Field work	03	50	-	50
GEO-P-106	Practical Covering CC103,CC104 and Field work	03	50	-	50
	<b>Total</b>	<b>22</b>	<b>420</b>	<b>80</b>	<b>500</b>

**SECOND SEMESTER**

Course Code	Title of the paper	Credits	Max. Marks		Total
			End-Sem.	Mid-Sem.	
GEO-CC-201	Stratigraphy & Paleontology	04	80	20	100
GEO-CC-202	Crystallography and Mineralogy	04	80	20	100
GEO-CC-203	Structural Geology & Geotectonics	04	80	20	100
GEO-CC-204	Engineering Geology & Hydrology	04	80	20	100
GEO-P-205	Practical Covering CC201,CC202 and Field work	03	50	-	50
GEO-P-206	Practical Covering CC203,CC204 and Field work	03	50	-	50
GEO-VAC-1					
	<b>Total</b>	<b>22</b>	<b>420</b>	<b>80</b>	<b>500</b>

**THIRD SEMESTER**

Course Code	Title of the paper	Credits	Max. Marks		Total
			End-Sem.	Mid-Sem.	
GEO-CC-301	Geophysics	04	80	20	100
GEO-CC-302	Research Methodology	04	80	20	100
GEO-CC-303	Economic & Ore Geology	04	80	20	100
GEO-OEC-304	Environmental Geology	04	80	20	100
GEO-P -305	Practical Covering CC301&CC302 and Field work	03	50	-	50
GEO-P-306	Practical Covering CC303 and Field work	03	50	-	50
GEO-VAC-2					
	<b>Total</b>	<b>22</b>	<b>420</b>	<b>80</b>	<b>500</b>

**FOURTH SEMESTER**

Course Code	Title of the paper	Credits	Max. Marks		Total
			End-Sem.	Mid-Sem.	
GEO-CC-401	Climatology	04	80	20	100
GEO-DSE-402	Oceanography	04	80	20	100
	Coal & Petroleum	04	80	20	100
GEO-DSE-403	Applied Hydrogeology	04	80	20	100
	Remote Sensing & GIS	04	80	20	100
GEO-P-404	Practical Covering CC401,DSE402 and Field work	03	50	-	50
GEO-P-405	Practical Covering DSE403 and Field work	03	50	-	50
GEO-DC-406	Dissertation	04	100	-	100
	<b>Total</b>	<b>22</b>	<b>420</b>	<b>60</b>	<b>500</b>

Grand Total:

88 Credits

2000 Marks

**N.B-FIELD STUDY IS COMPULSORY FOR M.Sc. GEOLOGY STUDENTS**

## QUESTIONS PATTERN

### A. MID SEMESTER EXAMINATION-20 MARKS

SEMESTER	PATTERN OF EXAMINATION		
	WRITTEN	SEMINAR	VIVA-VOCE
<b>FIRST</b>	<ol style="list-style-type: none"><li>1. Igneous Petrology &amp; Geochemistry</li><li>2. Sedimentary Petrology</li></ol>	Earth System Sciences and Remote Sensing	Metamorphic Petrology
<b>SECOND</b>	<ol style="list-style-type: none"><li>1. Crystallography and Mineralogy</li><li>2. Structural Geology &amp; Geotectonics</li></ol>	Stratigraphy & Paleontology	Engineering Geology & Hydrology
<b>THIRD</b>	<ol style="list-style-type: none"><li>1. Geophysics</li><li>2. Economic &amp; Ore Geology</li></ol>	Environmental Geology	Research Methodology
<b>FORTH</b>	<ol style="list-style-type: none"><li>1. Climatology</li><li>2. Oceanography</li><li>3. Applied Hydrogeology</li><li>4. Coal &amp; Petroleum</li></ol>		Remote Sensing & GIS

### B. END SEMESTER EXAMINATION-80 MARKS

Questions will be set from each unit. There will be four questions in a paper. Each unit will have one long answer type question carrying 20 marks or 3 short answer type carrying 10,5,5 marks.

**Example:**

**Q.** Long answer type (20 Marks)

**OR**

- a. Explanatory note (10 Marks)
- b. Short note (5 Marks)
- c. Short note (5 Marks)

## SEMESTER -I

### GEO-CC– 101 IGNEOUS PETROLOGY &GEOCHEMISTRY

#### **UNIT-I:**

Concept of Magma; forms of Igneous Rocks; Texture of Igneous Rocks; Texture as clue to magma behaviour: Structures of Igneous Rocks and their significance; Bowen's Reaction Principles and its significance.

Crystallization behaviour of Binary Magma: Ab-An system: Foresterite Silica System, Leucite Silica system, Di - An System. System with limited solid solution (Or-Al System).

#### **UNIT-II:**

Crystallization behaviour of Ternary Magma: Di Ab-An-System; Variation diagrams, Use of Trace Elements in Igneous Petrology.

IUGS Classification of Igneous Rocks; Magmatic differentiation and assimilation, Plate Tectonics and Magmatism; Layered Mafic Intrusion; The Bushveld Complex, The Stillwater Complex.

#### **UNIT-III :**

Petrography of Granitoid Rocks, Alkaline Rocks, Ultramafic Rock, Anorthosite, kemberlite. Carbonatite, Basalt, Lamprophyres and Lamproites, Petrogenesis of Granite.

#### **UNIT-IV:**

Earth in relation to Solar System and Universe; Structure and Composition of Earth; Cosmic abundance of Elements; Types and Composition of Meteorites; Geochronology and Age of the Earth; Trace Elements.

Geochemical Classification of Elements, Isomorphism, Polymorphism, Pseudomorphism; Atomic Substitution; Exsolutions Geochemistry of Atmosphere, Hydrosphere; Geochemical Cycle.

#### **Selected Readings:**

1. **Tyrrell, G. W., 1979**, The principles of petrology, Chapman and Hall
2. **Winter, J. D., 2009**. An introduction to Igneous and Metamorphic petrology (2nd edition), Prentice Hall.
3. **Carmichael, I, Turner, F. and Verhoogen, F., 1974**. Igneous Petrology. McGraw Hill University Publication.
4. **Bose, M. K.,** Igneous Petrology,
5. **White, M., 2013**, Geochemistry, Wiley Publication.
6. **Hugh Rollinson**, using geochemical data to understand geochemical processes.
7. **Misra, K. C., 2012**, Introduction to Geochemistry - Principles and Applications, Wiley Blackwell Publications

## **GEO-CC-102 SEDIMENTARY PETROLOGY**

### **UNIT-I:**

General Process of Formation of Sedimentary Rocks; Distinctive features of Sedimentary Rocks Importance of Sedimentary Rocks, Texture of Sedimentary Rocks and their significance; Structure of Sedimentary Rocks and their significance, Diagenesis.

### **UNIT-II:**

Tectonics and Sedimentation Sedimentary Basin Analysis, Provenance, Geosynclines: Concept and Types, Sedimentary Environment: fluvial Environment, Lacustrine Environment, Marine Environment, Delta Environment, Carbonate and Evaporite Environment. Tidal Flat Environment, Sedimentary Basins of India.

### **UNIT-III:**

Classification of Sedimentary Rocks, Classification of Sandstones and Limestones, palaeocurrent analysis, elements of Hydraulics: Heavy Minerals Studies and their significance, Seismic Stratigraphy, Sequence Stratigraphy, Magneto-stratigraphy, Cyclic Sediments.

### **UNIT-IV:**

Petrography of Sandstone, Shale, conglomerate, Breccia, Carbonate Rocks, Evaporites and Phosphates.

### **Selected Readings:**

1. **F. J. Pettijohn**, Sedimentary rock
2. **S. M. Sengupta**, Introduction to sedimentology
3. **Maurice. C. Tucker**, Sedimentary Petrology
4. **V.K. Verma and C. Prasad**, Textbook of sedimentary petrology
5. **Maurice. C. Tucker**, Sedimentary Petrology
6. **Tyrrell, G. W., 1979**, The principles of petrology, Chapman and Hall

## **GEO-CC-103 METAMORPHIC PETROLOGY**

### **UNIT-I:**

The limits of Metamorphism, The Metamorphic Agents, Types of Metamorphism, Metamorphic Reactions, Metamorphic Zone, Grade of Metamorphism, Metamorphic Facies, ACF diagram; AKF diagram; Texture and Structure of Metamorphic Rocks.

### **UNIT-II:**

Metamorphism of Pelitic Rocks, Metamorphism of Ultramafic Rocks, Metamorphism of Calcareous Rocks, Metamorphism and Global Tectonics, Time, Temperature and Deformational relationship.

Nomenclature and classification of Metamorphic Rocks; Granitisation, Granulite Terrain of India; Metamorphic Differentiation, Metasomatism; Paired Metamorphic Belt.

### **UNIT-III:**

Petrography of Gneiss, Schist, Quartzite, Slate, Marble, Khondalite, Charnokite, Migmatites, Phyllite, Skarn.

### **UNIT-IV:**

Equilibrium concept in thermodynamics; laws of thermodynamics, enthalpy, entropy, Gibb's free energy, chemical potential, fugacity and activity; tracing the chemical reactions in P-T space, phase rule and mineralogical phase rule in multi-component system; Clausius-Clapeyron equation and slopes of metamorphic reactions; heat flow, diffusion and mass transfer; geothermobarometry.

### **Selected Readings:**

1. **Winter, J. D.** An introduction to Igneous and metamorphic petrology
2. **A. Miyashiro.** Metamorphic Petrology
3. **B. Bhasker Rao,** Metamorphic Geology
4. **Greg Anderson** ,thermodynamics of natural system

## **GEO-CC-104 EARTH SYSTEM SCIENCES AND REMOTE SENSING**

### **UNIT-I:**

Seismology and Interior of the Earth; Volcanos: Types, Products, Topography, Distribution and Effects; Earthquake Causes, Effects, Seismic Belts and Prediction of Earthquake; Types of Weathering and Significance.

### **UNIT-II:**

Basic Principles in Geomorphology; Fluvial Landforms, Aeolian Landforms, Glacial Landforms, Coastal Landforms, Karst Topography.

### **UNIT-III:**

Drainage Pattern, Morphometric Analysis of Drainage Basin; Davis Geomorphic Cycle; Rejuvenated Landforms, Application of Geomorphology in Different Fields; Physiographic divisions of India.

### **UNIT-IV:**

Principle of remote sensing ;Electromagnetic spectrum; electromagnetic bands in remote sensing; spectral signatures of soil, rock, water and vegetation; thermal, near infra-red and microwave remote sensing; digital image processing; LANDSAT, IRS and SPOT- characteristics and use; Application of remote sensing in minerals exploration, ground water exploration and geomorphology.

Principles of aerial Photography , types, scale, parallax, relief displacement; elements of image interpretation, stereoscopy, Application of aerial photography in minerals exploration, ground water exploration and geomorphology.

### **Selected Readings:**

1. **Eric Bird**, Coastal Geomorphology, 2nd Edition, John Wiley & Sons, West Sussex, 436p.
2. **S. Singh**, Textbook of geomorphology
3. **S. Singh**, Textbook of geomorphology
4. **K. Siddhartha**, Textbook of geomorphology
5. **G.B. Mohapatra**, A textbook of geomorphology
6. **John R. Jensen**, Remote Sensing of the environment – An earth resource perspective  
2nd Edition, Pearson, Edinburgh, 619p.
7. **Ravi P. Gupta**, Remote Sensing Geology, 2nd Edition, Springer, Berlin, 671p
8. **Basudeb Bhatta** , Remote sensing and GIS 2<sup>nd</sup> edition

## **GEO-P-105 PRACTICAL**

**F.M: 50**

**Time: 3 hours**

1. Megascopic Identification of Igneous & Sedimentary Rocks
2. Microscopic Identification of Igneous & Sedimentary Rocks
3. Norm Calculation
4. Sedimentary grain size analysis & interpretation
5. Palaeocurrent analysis
6. Lab Records
7. Viva-Voce

## **GEO-P-106 PRACTICAL**

**F.M: 50**

**Time: 3 hours**

1. Megascopic Identification Metamorphic Rocks
2. Microscopic Identification of Metamorphic Rocks
3. Plotting of ACF, AKF diagram
4. Drainage Pattern Study and Basin Analysis
5. Lab Records
6. Viva-Voce



## SEMESTER - II

### GEO-CC -201 STRATIGRAPHY AND PALEONTOLOGY

#### UNIT-I:

Principles of Stratigraphy Principles of Stratigraphy; Stratigraphic Correlation; Code of Stratigraphic Nomenclature.

Precambrian Stratigraphy; Precambrian stratigraphy of India-General characters, Lithology, Structure, Stratigraphy and Mineral resources of Dharwar, Aravalli, Cuddapah, Vindhyan, Eastern Ghats, Iron Ore Super group.

#### UNIT-II:

General Characters ,Lithology, Structure, Stratigraphy, Fossil assemblages and Mineral resources of Gondwana, Triassic of Spiti, Jurassic of Kutch.

General characters, Lithology, Structure, Stratigraphy, Fossil assemblages and Mineral resources of Tertiary of Assam, Siwaliks, Cretaceous of Trichinopoly, Deccan traps.

#### UNIT-III:

Morphology, Classification and evolution of Brachiopods, Pelecypods & Gastropods.

Morphology, Classification and evolution of Echinoids, Cephalopods, Trilobites and Corals.

#### UNIT-IV:

Mass Extinctions; Vertebrates- Proboscidea, Equidae & Hominidae ;Paleobotany.

Micro Paleontology- Foraminifers, Conodonts and Radiolarians; Gondwana Flora & its significances.

#### Selected Readings:

1. **Rabindra Kumar** Fundamentals of historical geology and stratigraphy of Odisha
2. **M.K.Krishnan** Geology of India and Burma
3. **D.N. Wadia** Textbook of stratigraphy of India
4. **M.S. Anantharaman** Paleontology
5. **Shorek and Twinhofel** Introduction to paleontology
6. **P. K. Saraswati & M.S. Srinivasan** Micropaleontology
7. **Amal Dasgupta** An Introduction To Paleontology

## **GEO-CC -202 CRYSTALLOGRAPHY AND MINERALOGY**

### **UNIT-I:**

Physical Properties of Minerals; Silicate Structure; Study of Structure, Chemical composition, Physical and Optical Properties of Olivine, Garnet, Pyroxene, Amphibole Group of Minerals.

### **UNIT-II:**

Study of Structure, Chemical Composition, Physical and Optical Properties of Feldspars, Felspathoids, Silica, Alumino-silicates, Carbonates, Mica Group.

### **UNIT-III:**

Polarisation; Double Refraction and Nicol Prism, Preparation of Thin Section, Parts and Function of Microscope; Behaviour of light in thin section Accessory Plates, Birefringences, Pleochroism, Interference Colour, Extinction.

Uniaxial Interference Figure; Biaxial Interference Figure; Dispersion: An Outline Study of Optical Properties of Minerals Studied under Microscope; Elementary idea on Universal Stage.

### **UNIT-IV:**

Symmetry Operation; Space Lattices; Crystal Imperfection and Twinning in Crystals; Crystal system; H M Symbol; Stereographic Projections of Crystals; X-Ray Crystallography.

### **Selected Readings:**

1. **William D. Nesse**, Introduction to mineralogy, Oxford University Press, New York, 457p.
2. **C. Klein, A. R. Philpotts**, Earth Materials – An introduction to mineralogy and Petrology, Cambridge University Press, New York, 1254p.
3. **C. D. Gribble**, Rutley's Elements of Mineralogy, 27th Edition, Unwin Hyman, London, 493p.
4. **C. W. Correns**, Introduction to Mineralogy, Crystallography and Petrology, 2nd Edition, Springer-Verlag, Berlin, 490p.

## **GEO-CC-203 STRUCTURAL GEOLOGY & GEOTECTONICS**

### **UNIT-I:**

Concept of Stress and Strain, Attitude of Beds, Deformation Mechanism, Relation between Deformation and Metamorphism, Relation between Deformation and Plutonism Determination of Strain in Rocks, Elastic, Viscous and Plastic Models of Rock behaviour; Top and Bottom Criteria.

### **UNIT-II:**

Ramsay Classification of Folds, Mechanism of Folding; Classification of Faults; Mechanism of Faulting; Ramp Flat Geometry; Recognition of Fault; Joints: Types and Significance.

### **UNIT-III:**

Unconformity Types and Recognition in the field; Foliation : Types and their relation with major structures, lineation : Types and their relation with major Structures, Shear Zone: Concept and Types, Salt Dome; Granite Tectonics; Tectonites.

### **UNIT-IV:**

Concept of Plate Tectonics; Continental Drift; Sea Floor Spreading, Geodynamics of Indian Plate, Neotectonic Movements; Tectonic Design and Evolution of Himalayas.

### **Selected Readings:**

1. **George H Davis and Stephen J Reynolds**, Structural Geology of Rocks and Regions, 2nd Edition, John Willey & Sons, New York, 792p
2. **Marland P Billings**, Structural Geology, 3rd Edition, PHI Learning, New Delhi, 606p.
3. **Haakon Fossen**, Structural Geology, Cambridge University Press, New York, 481p.

# **GEO-CC-204 ENGINEERING GEOLOGY & HYDROGEOLOGY**

## **UNIT-I:**

Geological Investigation for Dam & Reservoir, Tunnel, Bridge, Stability of Slopes and coastal protection structures.

## **UNIT-II:**

Engineering Properties of Rocks (Building Stones)Crushing Strength, Transverse Strength, Porosity, Density, Abrasive Resistance, Frost fire Resistance, Durability and Appearance. Engineering Properties of Rocks for Foundation Purpose.

Laboratory Test Uniaxial Compressive Strength, Tensile Strength, Shear Strength, Modulus of Elasticity, Triaxial Test ;Field Test - Jack Test, Shear Test, Seismic Test.

## **UNIT-III:**

Water on Earth, Types of Water Juvenile, Meteoric, Sea, Hydrological cycle and its Components, Water balance, Vertical distribution of ground water, Hydrological properties of water bearing formations- Porosity, Permeability, Specific Yield & Specific Retension, Darcys Law & its application.

## **UNIT-IV:**

Classification of rocks according to their water bearing properties, Aquifers, Types of Aquifers, Concept of drainage basins and ground water basins, Aquifer parameters. Transmissivity and Storage Coefficient, Water Table and its Fluctuation, Ground water provinces of Odisha&India.

## **Selected Readings:**

1. **B. Singh and R K Goel** ,Engineering rock mass classification
2. **Parbin Singh** ,Engineering and general Geology
3. **D. K. Todd**, Groundwater Hydrology, 3rd Edition, John Wiley & Sons, USA, 652p
4. **K. R. Karanth**, Groundwater Assessment Development and Management, Tata McGraw Hill, New Delhi, 720p
5. **C. W. Fetter** ,Applied hydrogeology ,4<sup>th</sup> edition
6. **Sanjay Akhauri and H. M. Akhauri** ,Fundamental of hydrogeology

## **GEO-P-205 PRACTICAL**

**F.M: 50**

**Time: 3 hours**

1. Plotting of different Stratigraphic formations in outline Map of Odisha,India.
2. Stratigraphic groups
3. Chronological Arrangement of Rock Units
4. Identification of Fossils
5. Chronological Arrangement of Fossils
6. Megascopic&MicroscopicIdentificationMinerals
7. determination of Extinction angle and optic sign of Minerals
8. determination of Extinction angle and optic sign of Minerals
9. Identification &Stereographic Projection of Crystal Models
10. Lab Records
11. Viva-Voce

## **GEO-P-206 PRACTICAL**

**F.M: 50**

**Time: 3 hours**

1. Dip, Strike Problems, Three Point Problems
2. Structural Problems through Stereo Net-map
3. Completion of Outcrop, Section Studies
4. Tectonic Maps, Engineering Maps , Hydrological Maps and Problems
5. Study of building stone
6. Lab Records
7. Viva-Voce

## **SEMESTER -III**

### **GEO -301 GEOPHYSICS**

#### **Unit-I:**

The earth as a planet, Earth's Figure and Gravity, Gravity Anomalies, Isostasy, Rheology.

#### **Unit-II:**

Seismology; Elasticity theory, Seismic waves, Seismic wave propagation, Internal structure of the earth.

#### **Unit-III:**

Geochronology; Geoelectricity; Electric field And Potential, Ohm's Law; Electrical Survey; Self Potential ;SP Surveying; Telluric Current; Resistivity Survey; Electromagnetic Survey.

#### **Unit-IV:**

Geomagnetism and Paleomagnetism:; The physics of magnetism, Rock magnetism, Magnetic surveying, geomagnetic polarity.

Introduction to well logging.

#### **Selected Readings:**

1. **William Lowrie**, Fundamentals of Geophysics, 2nd Edition, Cambridge University Press, Cambridge, 393p.
2. **Robert j. Lillie**, whole earth geophysics
3. **W. M. Telford, L. P. Geldart and R. E. Sheriff**, Applied Geophysics, 2nd Edition, Cambridge University Press, Cambridge, 759p
4. **Alane Mussett &M. Aftab Khan**, looking into the earth
5. **George Asquith** ,Basic well log analysis by geologist

## **GEO-302 RESEARCH METHODOLOGY**

### **UNIT-I:**

Meaning, Objectives, Types and Significance of Research Research Methods. Research Problems, Criteria for Good Research; Problems Encountered by Researchers in India; Defining the Research Problem.

### **UNIT-II:**

Research Design; Design of Sample Surveys: Measurements, Scaling, Data Collection, Data Preparation, Statistical Parameters in Geology: Interpretation and Report Writing: Ethics in Research.

### **UNIT-III:**

Fundamental of Geological Mapping: Qualitative Analysis of Groundwater, Electrical Resistivity Survey, Grain Size Analysis and Interpretation.

### **UNIT-IV:**

Basics of Aerial Photography, Basics of Remote Sensing, Applications of Aerial Photography and Remote Sensing in Geological Mapping, Ground Water Studies and Mineral Exploration, Elementary Idea on GPS, Elementary Idea on GIS.

### **Selected Readings:**

1. **C R Kothari & Gaurav Garg** Research Methodology, Methods & Techniques

## **GEO-303 ECONOMIC & ORE GEOLOGY**

### **UNIT-I:**

Distribution of mineral deposits in Indian shield; geological characteristics of important industrial mineral and ore deposits in India- chromite, diamond, muscovite, Cu-Pb-Zn, Sn-W, Au, Fe-Mn, bauxite; minerals used in refractory, fertilizer, ceramic, cement, glass, paint industries; minerals used as abrasive, filler; building stones.

Strategic, critical and essential minerals; India's status in mineral production; co-products and byproducts; consumption, substitution and conservation of minerals; National Mineral Policy ; Mineral Concession Rules; marine mineral resources and laws of the sea.

### **UNIT-II:**

Coal and its properties; proximate and ultimate analysis; different varieties and ranks of coal; concept of coal maturity, peat, lignite, bituminous and anthracite coal; origin of coal, coalification process; lithotypes, microlithotypes and maceral groups of coal; mineral and organic matter in coal; lignite and coal deposits of India.

Origin, migration and entrapment of natural hydrocarbons; characteristics of source and reservoir rocks; structural, stratigraphic and mixed traps; geological, geochemical and geophysical methods of hydrocarbon exploration; petroliferous basins of India; geological characteristics and genesis of major types of U deposits and their distribution in India.

### **UNIT-III:**

Stages of exploration; scope, objectives and methods of prospecting, regional exploration and detailed exploration; geological, geochemical and geobotanical methods; litho-, bio-, soil geochemical surveys, mobility and dispersion of elements, geochemical anomalies; ore controls and guides; pitting, trenching, drilling; sampling, assaying, ore reserve estimation; categorization of ore reserves.

### **UNIT-IV:**

Ore minerals and industrial minerals; physical and optical properties of ore minerals; ore textures and paragenesis; characteristics of mineral deposits- spatial and temporal distribution, rock-ore association; syngenetic and epigenetic deposits, forms of ore bodies, stratiform and strata-bound deposits; ore forming processes- source and migration of ore constituents and ore fluid, mechanism of ore deposition; magmatic and pegmatitic deposits (chromite, Ti-magnetite, diamond, Cu-Ni sulphide, PGE, REE, muscovite, rare metals).

Hydrothermal deposits (porphyry Cu-Mo, greisen SnW, skarn, VMS and SEDEX type sulphide deposits, orogenic gold); sedimentary deposits (Fe, Mn, phosphorite, placer); supergene deposits (Cu, Al, Ni and Fe); metamorphic and metamorphosed deposits (Mn, graphite); fluid inclusions in ore mineral assemblage- physical and chemical properties, microthermometry.

### **Selected Readings:**

1. **Jensen and Batman** Economic mineral deposits
2. **A. K. Sen and P. K. Guha** A handbook of economic Geology
3. **S.K. Tiwari**, Ore geology, Economic mineral and mineral economics
4. **R.N.P. Arogyoswami** Mining geology
5. **Swapan Haldar** ,Mineral exploration



## **OEC-304 ENVIRONMENTAL GEOLOGY**

### **UNIT-I:**

Dimension of environmental stress, Spectrum of Environmental Geology, Soil Erosion and Conservation, Desertification and degradation of Land, Causes and Measures to Combat Desertification.

### **UNIT-II:**

Impact of Mining Activities on Environment, Effects of Excessive Withdrawal of Ground Water, Environmental Effect of River Valley Project, Rain Water Harvesting, Waste Disposal, Conservation and Substitution of Mineral Resources.

### **UNIT-III:**

Natural Hazards Their Zoning and Risk Assessment, Earthquake and Seismic Hazards, instability of Slopes and landslides, Coastal Hazards. Cyclones and Tsunamis, Volcanic and Hazards.

### **UNIT-IV:**

Pollution, Sources of Contamination of Water, Treatment of Polluted Waters, Nature and Effects of Air Pollution, Noise Pollution, Alternative Sources of Energy Solar Energy, Wind Energy. Energy from Waves and Tides, Geothermal Energy and Nuclear Energy.

### **Selected Readings:**

1. **D. S. Lal** A textbook of Climatology
2. **K. S. Valdiya** Environmental Geology
3. **S. Singh** Environmental Geography

## **GEO-P-305 PRACTICAL**

**F.M: 50**

**Time: 3 hours**

1. Practical covering GEO-CC-301 Geophysics and GEO-CC-302 research methodology

## **GEO-P-306 PRACTICAL**

**F.M: 50**

**Time: 3 hours**

1. Megascopic Identification of Ores
2. Study of Ore Texture
3. Ore Reserve Estimation
4. Blow pipe Analysis

## **SEMESTER -IV**

### **GEO-CC-401 CLIMATOLOGY**

#### **UNIT-I:**

Composition, Vertical structure, Weather and climate, Temperature and heat transfer, Latent heat, Conduction, Convection, The earth's annual budget, Seasons, Daily air temperature variations, humidity, condensation, and clouds.

#### **UNIT-II:**

Atmospheric Stability, Unstable and Conditionally unstable atmosphere, Cloud development and stability, Precipitation processes, Precipitation types.

#### **UNIT-III:**

Atmospheric pressure, Why the wind blows, Surface winds, Scales of atmospheric motion, Local wind systems, Global wind system, Single and Three cell model of atmospheric circulation, ENSO.

#### **UNIT-IV:**

Air masses, Fronts, Cyclones, Thunderstorms, Hurricanes, Tornadoes, Air Pollution, Global Climate, Climate Classification, Climate Change.

#### **Selected Readings:**

1. **C. Donald Ahrens**, Essentials of Meteorology, 5th Edition, Thomson, Belmont, 504p.
2. **R. G. Barry and R. J. Chroley**, Atmosphere, Weather and Climate, 9th Edition, Routledge, London, 533p

# GEO-DSE-402 OCEANOGRAPHY

## UNIT-I:

**Introduction:** History of Marine Science; Origin of the oceans; Distribution of land and sea on earth's surface; Ocean bottom relief; Continental shelves, slope, submarine canyons, Continental rise, abyssal plains, Mid-Oceanic Ridges, Volcanic Seamounts, Guyots, Trenches, Island Arcs.

## UNIT-II:

**Oceanic Sediments:** Oceanic sediments vary in appearance, Sediment classification by particle size and source, Neritic sediments, Pelagic sediments, Terrigenous and Biogenous deposits, Turbidites, Oozes, Evaporites, Oolite Sands.

## UNIT-III:

**Water and Ocean Structure:** Unusual thermal characteristics of water molecule, Surface water regulates global temperature, Ocean is stratified by density; Ocean Chemistry: Ocean water salinity, Dissolved solids in oceanic water, Dissolved gases in oceanic water.

## UNIT-IV:

**Circulation of the Oceans:** The Coriolis Effect, Surface currents are driven by winds, Westward Intensification, Oceanic Gyres, Coastal Upwelling, El Nino, La Nina, Thermohaline Circulation.

### Selected Readings:

1. **T. Garrison and R. Ellis**, Oceanography – An Invitation to Marine Science, CENGAGE Learning, Boston, 646p
2. **P. S. Meadows** etc., An Introduction to Marine Science, John Wiley & Sons, New York, 294p
3. **Trujillo Thurman**, Essential Of Oceanography
4. **P.R Pinet** ,Introduction to Oceanography 5<sup>th</sup> Edition

# **GEO-DSE-402 COAL AND PETROLEUM**

## **UNIT-I:**

Introduction; Ranks of Coal; Classification; Chemical Properties; Mode of Occurrence.

Origin of Coal; Geological Formation of Coal Deposits; Coal Sampling and Analysis.

## **UNIT-II:**

Fundamental of Coal Petrology; Macroscopic and Microscopic Constituents of Coal; Coal and Environment; Geology and Coal Mining.

Coal and Lignite Resources of India; Hydrogeology of Coal; Coal as an alternative Source of energy; Coal Marketing.

## **UNIT-III:**

Introduction; Origin of Petroleum; Types of Reservoir rocks; maturation of kerogen; Biogenic and thermal effects; Oil Traps; Uses of Petroleum.

## **UNIT-IV:**

Petroleum Exploration; Petroleum and environment; Composition of Crude Oil; Natural Gas.

Distribution of Oil and Gas in India ;Sources of Mineral Oil; Oil Shale; Black Shale; CBM; Oil from Plants.

## **Selected Readings:**

1. **A.L. Levorsen** -Geology of Petroleum
2. **Larry Thomas**- Coal Geology

## **GEO-DSE- 403 Applied Hydrogeology**

### **UNIT-I:**

Hydrological Cycle; Vertical Distribution of Sub-Surface Water; Properties of Water bearing Formations; Types of Aquifers; Darcy's Law, Ground Water Exploration, Geomorphic and Geological Controls on Ground Water.

### **UNIT-II:**

Quality of Ground Water and its uses in Domestic and Irrigational Field; Groundwater Pollution and Legislation; Sea Water Intrusion; Consequences of Excessive Withdrawal of Ground Water; Fluoride in Ground Water; Arsenic Problem in Ground Water, Thermal Springs of Odisha.

### **UNIT-III:**

Rain Water Harvesting; Artificial Recharge of Ground Water; Watershed Management; Failures of Tube Wells; Types of Wells; Drilling Methods; Ground Water Development and Management.

### **UNIT-IV:**

Hydrogeological Research in India; Hydrogeological setting of India; Ground Water Occurrences & Movement; Aquifer Characteristics in Consolidated Formation; Ground Water Provinces of India; Ground Water Provinces of Odisha.

### **Selected Readings:**

1. **D. K. Todd**, Groundwater Hydrology, 3rd Edition, John Wiley & Sons, USA, 652p
2. **K. R. Karanth**, Groundwater Assessment Development and Management, Tata McGraw Hill, New Delhi, 720p
3. **C. W. Fetter** ,Applied hydrogeology ,4<sup>th</sup> edition
4. **Sanjay Akhauri and H. M. Akhauri** , Fundamental of hydrogeology

## **GEO-DSE-403 REMOTE SENSING &GIS**

### **UNIT-I:**

Concept of remote Sensing; Remote sensing Process; Sources of Energy; Electromagnetic Spectrum; interaction with the Atmosphere; Advantages of Remote Sensing; Limitation of Remote Sensing.

### **UNIT-II:**

Types of Remote Sensing; Type of Platforms and their application Sensors; Digital Image Processing; Remote sensing Systems; History of Remote sensing and Indian Space Program.

### **UNIT-III:**

Application of Remote sensing in Geology; Remote sensing for mapping and monitoring of Landuse Land cover; Remote sensing in ground water studies; Remote sensing for Ocean resources and Coastal monitoring; Remote sensing application to Forestry and Environment.

### **UNIT-IV:**

GIS definition. Key component of GIS; GIS an integration of spatial and attribute information; GIS A knowledge Hub; Application of GIS. Advantages of GIS; Functional Requirement of GIS; Fundamentals of Global Positioning System (GPS); Application of GPS.

### **Selected Readings:**

1. **John R. Jensen**, Remote Sensing of the environment – An earth resource perspective  
2nd Edition, Pearson, Edinburgh, 619p.
2. **Ravi P. Gupta**, Remote Sensing Geology, 2nd Edition, Springer, Berlin, 671p.
3. **Basudeb Bhatta** ,Remote sensing and GIS 2<sup>nd</sup> edition

## **GEO-P- 404 PRACTICAL**

**F.M: 50**

**Time: 3 hours**

Practical covering GEO-CC-401 Climatology and GEO-DSE-402

## **GEO-P 405 PRACTICAL**

**F.M: 50**

**Time: 3 hours**

1. Hydrological Maps
2. Hydrological Problems.
3. Resistivity Problems.
4. Water Quality Chemical Data Plotting.
5. Remote Sensing Maps for Hydrological Study.
6. Determination of Water Quality Parameter.
7. Lab Record and Viva-Voce



## **GEO-DC- 406 DISSERTATION**

**F.M: 100**

**Dissertation: 50**

**Seminar and Viva: 50**

### **Dissertation Topics:**

1. Geological Mapping
2. Remote Sensing and GIS
3. Groundwater Studies
4. Engineering Geology
5. Economic Geology
6. Fossil Studies
7. Environmental Geology
8. Applied Geology
9. Mining Geology
10. Geological Resource Management.
11. Any other topic related to Geology