COURSES OF STUDIES
FOR
M.Sc. EXAMINATION
(With effective from 2021-2022)

GEOLOGY

(Semester System)

DEPARTMENT OF GEOLOGY
MSCBD UNIVERSITY
Keonjhar Campus,
Keonjhar-758002

M.Sc. (GEOLOGY) EXAMINATION

SEMESTER SYSTEM

(Choice Based Credit System)

1. The course is of two years duration comprising of four semesters of theory and laboratory works.
2. The elective courses comprising of two papers for which the student can opt for any one group from the elective course at the beginning of the Semester-IV.
3. Each student has to carry out project work from Semester-III and submit a dissertation before the commencement of Semester-IV theory examination.
4. The theory examination carrying 100 marks have external valuation of 80 marks and an Internal Assessment Examinations (IAE) valuation of 20 marks. The durations of the practical examination shall be 6 hours.
5. The external valuation of 80 marks will be held for 3 hours duration and the IAE valuation of 20 marks will have 1 hour duration.
6. For IAE, question shall be asked at least from any two units of a paper covered. The questions shall be of unit pattern, having equal marks, with two alternatives from each unit.
7. For passing semester examinations a candidate must secure a minimum of 40% marks in practical and 30% marks in theory papers.
8. A student securing cumulative Grade Point Average (CGPA) 5.5 shall be declared as pass the Post-Graduation Examination.
9. A candidate securing at least 6.75 CGPA (minimum 60% marks in aggregate) shall be declared as First Class. The First Class First student shall receive the University Gold Medal in the concerned regular P.G. Course provided that he/she has cleared all the papers of the semester examinations in one chance.
10. If candidate passes all the four semester examinations, he/she will be declared to have passed the M.Sc. (Semester) examinations in Geology, provided further that in no case a candidate shall be allowed to appear any Semester Examination after twice the duration of course period.
11. In order to be eligible to appear at the University examination, a student has to secure at least 75% of attendance.

Programme Outcome:

- The courses offered by the department covers a wide range of core courses in geology. These courses are designed so that the students are equipped with both theoretical constructs and practical applications of the subjects. It includes teaching in geomorphology, sedimentology, geochemistry, stratigraphy, mineralogy, petrology, environmental geology, economic geology and geophysical principles. As the University is placed in the heart of mineral rich Precambrian terrain, foremost important is given to the economic ore geology and field training programme. The academic curriculum of the Department will helps a good number of students to qualify in national level competitive examinations including NET, GATE, and pursue their carrier in different geoscientific organization.

Programme Specific outcome:

- Students will gain demonstration skill in earth materials as well as learn Dynamic nature of Earth processes, sedimentation and stratigraphy, deformational processes, structural features and geomorphic processes and landforms.

- They can investigate different mineral resources, formation, extraction, and uses of physical resources with respect to ores, fossil fuels and ground water through elective courses.

- They can be able to do the geological mapping independently or as part of a team and interpreting and evaluating geological data and write the result as a technical reports/dissertation and present their research orally.

- After completion of the course, they can be able to pursue their carrier in various industries based geoscientific organization.

- They will develop creative thinking and discuss how people use common geological resources.

- Mentor system will motivate them towards research in geology and capable of taking up higher studies of interdisciplinary courses.

P.G. DEPARTMENT OF GEOLOGY

MSCBD UNIVERSITY

M.Sc. SYLLABUS

SEMESTER - I

Code	Title	Credit	Marks		Total
			Internal	Semester	
GL-401	Igneous Petrology	05	20	80	100
GL-403	Sedimentary Petrology	05	20	80	100
GL-405	Metamorphic Petrology & Geochemistry	05	20	80	100
GL-407	Geomorphology & Marine Geology	05	20	80	100
GL-409	Practical Related to above papers	05	--	100	100
Total		**25**	**80**	**420**	**500**

SEMESTER - II

Code	Title	Credit	Marks		Total
			Internal	Semester	
GL-402	Earth system science	05	20	80	100
GL-404	Crystallography & Marine science	05	20	80	100
GL-406	Structural Geology & Geotectonics	05	20	80	100
GL-408	Research Methodology	05	20	80	100
GL-410	Practical relating to above papers	05	--	100	100
OE-GL-412	Basics of Remote Sensing	05	20	80	100
Total		**30**	**100**	**500**	**600**

SEMESTER - III

Code	Title	Credit	Marks		Total
			Internal	Semester	
GL-501	Environmental geology & Disaster management	05	20	80	100
GL-503	Stratigraphy & Paleontology	05	20	80	100
GL-505	Ore Geology	05	20	80	100
GL-507	Hydrogeology /Coal & Petroleum Geology (EL-1)	05	20	80	100
GL-509	Practical related to above paper	05	-	100	100
Total		**25**	**80**	**420**	**500**

SEMESTER - IV

Code	Title	Credit	Marks		Total
			Internal	Semester	
GL-502	Economic Mineral Deposit	05	20	80	100
GL-504	RS & GIS Mining & mineral Economic (EL-II)	05	20	80	100
GL-506	Practical related to 502/504	05		100	100
GL-508	Project work & Viva-voce	05		100	100
	Total	**20**	**40**	**360**	**400**
	GRAND TOTAL	**100**			**2000**

FIRST SEMESTER

IGNEOUS PETROLOGY

GL-401 **20+80 Marks**

Course Objective: The objective of the course is to make understand the students about the nuances of different types of rocks and their genesis.

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UNIT- I **(25)**

Concept of magma, Form of Igneous rock, Texture of Igneous rock, Texture as clue to magma behavior, Structure of Igneous rock & their significance. Bowen's Reaction Principle and its significance.

UNIT-II **(25)**

Crystallization behavior of Component magma, D-Ab-An system, Eutectic crystallization (Di-An system), System with limited solid solution (Or-Ab system)

UNIT–III **(25)**

Variation diagrams, Use of trace element in igneous petrology, differentiation, and assimilation layered mafic intrusions. The Bushveld complexes. The still water complexes.

UNIT – IV **(25)**

IUGS classification of Igneous rock, Tyrell Tabular classification of Igneous rock, Plate tectonic & magma Lunar geology, Brief idea about Geology of Antarctica. Petrology of alkaline rocks, Ultramafic rock, Anorthosite, kimberlite, Carbonatite, Basalt, lamprophyre & Lamproite, Petrography and petrogenesis of Granite.

Course Outcome: This is an introductory course in which the students will come out with the basic understanding on the concept of magma, how magma forms and the factors that influence the formation and its Crystallization behavior under varying cooling history. They also learn how different kinds of igneous rocks and rock suites form under different tectonic conditions their relationships, its texture, structure and Classification and can link these aspects to interpolate how geology can be explored when considering the environmental management and sustainability. They will have expertise and ability to recognise and identify the common igneous rocks both in the field and from hand samples and thin sections. The course has a very good potential to make the students amply sought after w.r.t. Mining & Petroleum industry after their successful completion.

Selected Readings:

1. **Winter, J. D., 2009**. An introduction to Igneous and Metamorphic petrology (2^{nd} edition), Prentice Hall.
2. **Carmichael, I, Turner, F., and Verhoogen, F.,** 1974. Igneous Petrology. McGraw Hill University Publication.
3. **Bose, M. K.,** Igneous Petrology,

SEDIMENTARY PETROLOGY

GL-403 **20+80 Marks**

Course Objective: The objective of the course is to make students understand the varied environments under which the sedimentary rocks are formed and their characteristics thereof.

UNIT – I **(25)**

Process of formation of Sedimentary rocks. Texture of sedimentary rock & their significance, Diagenesis. Structure, importance of sedimentary rock.

UNIT – II **(25)**

Plate Tectonic & sedimentary basin. Techniques of basin analysis, Lithostratigraphy Chromo stratigraphy Bio stratigraphy, Sedimentary basin of India, Provenance.

UNIT – III **(25)**

Sedimentary environments. continental terrestrial environment, Silici-clastic marine environmental marginal marine environmental. carbonate & evaporate environment.

UNIT –IV **(25)**

Petrography of sandstone, conglomerate mudstone and shale, carbonate. Sedimentary rock carbonaceous sedimentary rock, evaporate, phosphorite, Classification of Sedimentary rocks, paleo current analysis and element of hydraulics, heavy mineral studies, & their significance, seismic stratigraphy, sequence stratigraphy.

Course Outcomes: The completion of this course will provide the students a broad understanding on the mechanisms and processes that generate sediments and different sedimentary rocks; the description of different sedimentary rocks and recognition of its structures, texture, classification, and its importance. Students can interpret the tectonic setting and features of environments in which sediments accumulate and its application in different geoscientific field after successful accomplishment. The student will recognize the characteristics of the different types of sedimentary rocks, both in the field and from hand samples and thin sections. The course has a very good potential to make the students amply sought after w.r.t. Mining & Petroleum industry after their successful completion.

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

METAMORPHIC PETROLOGY & GEOCHEMISTRY

GL-405 **20+80 Marks**

Course Objective: The objective of the course is how temperature and pressure variation with respect to space and time brings about mineralogical as well as elemental changes in the earth lithic units

UNIT – I **(25)**

The limits of metamorphism, agents, types of metamorphism, agents, types of metamorphism, metamorphic reaction, metamorphic zones, grades, metamorphic facies, phase rule, ACF, AKF diagram, texture and structure of metamorphic rock.

UNIT – II **(25)**

Metamorphism of politic rock, metamorphism and global tectonics; paired metamorphic belts, Granulite terrain of India, Granitization Metasomatism.

UNIT – III **(25)**

Petrography of Khondolite, Charnockkite, Schist, gneiss, Slate, Marble, Migmatite, Skarn, Phyllite.

UNIT – IV **(25)**

Geochemical classification of elements, types & Composition of meteorite, structure and composition of earth, cosmic abundance of earth, trace elements, geochronology & age of the earth. Geochemistry of atmosphere, geochemistry of hydrosphere, Geochemical cycle, Isomorphism, pseudo morphism, atomic substitution, Exsolution.

Course Outcome: The course aims to educate students the concept of metamorphism, driving forces behind metamorphism and its types. To use macro- and microscopic textural evidence to identify the metamorphic rocks and use the mineral assemblage to identify the protolith and the metamorphic facies. They also understand the relationships between the plate tectonic settings and type of metamorphism. The student will recognize the characteristics of the different types of metamorphic rocks, both in the field and from hand samples and thin sections. The course will enable the students with fundamental of geochemistry on how different chemical principles are used to explain the mechanism that control the large geological systems such as earth's mantle, crust, ocean and atmosphere and the formation of solar system and in essence a broader perspective of our environment. The course has a very good potential to make the students amply sought after w.r.t. Mining & Petroleum industry as well as in various Research organizations after their successful completion.

Selected Readings:

1. **Winter, J. D**. An introduction to Igneous and metamorphic petrology.
2. **A. Miyashiro**. Metamorphic Petrology
3. **Misra, K. C.,** 2012, Introduction to Geochemistry - Principles and Applications, Wiley Blackwell Publications
4. **White, M., 2013**, Geochemistry, Wiley Publication.
5. **Hugh Rollinson,** using geochemical data to understand geochemical processes.
6. B. Bhasker Rao, Metamorphic Geology

GEOMORPHOLOGY, MARINE & ENGINEERING GEOLOGY

GL-407 **20+80 Marks**

Course Objective: The objective of the course is to make students appreciate the genesis of various landforms and their characteristics thereof.

UNIT – I **(25)**

The scope of Geomorphology, Basic principles in geomorphology, types of weathering and significance, physiographic divisions of India; Application of Geomorphology in different fields.

UNIT – II **(25)**

Fluvial landforms, drainage pattern, rejuvenated landforms, Aeolian landforms, Glacial landforms, Coastal geomorphology and Karst topography.

UNIT – III **(25)**

Davis geomorphic cycle, late quaternary climatic geomorphology; Cenozoic tectonism Cenozoic climate change, Tectonic landforms.

UNIT – IV **(25)**

Ocean bottom relief; Coral reefs: types, distribution, origin; marine sediments their distribution, sea level changes: mechanism evidence and impact. Law of sea, man and ocean. Engineering properties of rocks and soils. Geological consideration in the selection of tunnel and dam sites, Alkali –aggregate reactions; earthquake resistant structures; improvement of site condition.

Course Outcome: The student will understand the conceptual and dynamic aspects of landform development and their linkage to our environment. They also learn many facets of surface relief features and to understand various aspects of their growth and evolution on the Earth. The course will provide the basic knowledge and understanding in the engineering properties of rock and soil materials, and the geological factors affecting the stability of a structure on and in the soil. They have gained ability to give an account of engineering stability of slopes and protection of underground facilities in engineering geological point of view. The course has a very good potential to make the students amply sought after w.r.t. Mining & Petroleum industry as well as in various Research organizations after their successful completion.

Selected Readings:

1. **K.M. Bangar**, Principle of engineering geology
2. **S.Singh** , Text book of geomorphology
3. **K.Siddhartha**, Text book of geomorphology
4. **G.B. Mohapatra**, a textbook of geomorphology

PRACTICAL

GL-409 **100 Marks**

Course Objective: The objective of the course is to have students a hands-on experience of the microscopic and macroscopic identification of different rock types.

1. Interpretation of toposheet and drawing of topographic profile.
2. Numerical problem related to topographic map and drainage texture.
3. Drainage basin analysis, study and interpretation of geomorphic models.
4. Megascopic identification of Igneous rocks.
5. Megascopic identification of Sedimentary rocks
6. Megascopic identification of Metamorphic rock
7. Microscopic identification of Igneous rock.
8. Microscopic identification of Sedimentary rock
9. Microscopic identification of Metamorphic rock
10. Norm calculation
11. Niggli value calculation
12. Calculation of formulae of minerals from chemical analysis
13. Sedimentary grain size analysis & interpretation
14. Heavy mineral analysis & interpretation
15. Paleocurrent analysis
16. ACF, AKF diagram
17. Lab Record & viva
18. Field Report

Course Outcome: The course deals with the hands-on experience of the students in relation to the knowledge acquired from the theoretical aspects of petrology and geochemistry. The course has a very good potential to enhance the skills of the students in macroscopic as well as microscopic identification of rock and mineral properties.

SECOND SEMESTER

EARTH SYSTEM SCIENCE

GL-402 **20+80 Marks**

Course Outcome: The objective of the course is to make the students have a synoptic view of various earth system processes.

UNIT – I **(25)**

Solar system, seismology & interior of the Earth; Earthquake: cause, effects, prediction of earthquake seismic belts, Volcanoes: types, volcanic product, volcanic belt, volcanic topography.

UNIT – II **(25)**

Global change: global changes in short time scales. Global changes in longtime scale, the atmospheric circulation system, the circulation of the ocean; the cryosphere.

UNIT – III **(25)**

Circulation of the solid earth: anatomy of the earth, the theory of plate tectonics, sea floor spreading, continental drift, recycling of elements (Carbon Cycle).

UNIT – IV **(25)**

Origin of the earth & origin of life, effect of life on the atmosphere, biodiversity through earth history, human threats to biodiversity. Long term climate regulation, long time climate record, Variation in atmospheric co2 & climate during the phanerozoic, Pleistocene glaciations, global warming impact, adaption and mitigation, G lobal warming: Recent and future climate.

Course Outcome: This is an introductory course to provide the basic understanding on solar system, how the planet Earth has been evolved and its structure and all of these interlinked with our environment. The students will come to explore the complexity of relationships between the major activities happening in interior and exterior and gained knowledge in other major subsystems of the earth: atmosphere, biosphere, geosphere, and hydrosphere. They also explore how these interactions change with time through the study of earth system history. The course has a very good potential to make the students amply sought after w.r.t. Mapping industry as well as in various Research organizations after their successful completion.

Selected Readings:

5. J.A. Stewer, The unstable Earth
6. K. Siddharth, physical geology
7. G. B. Mahapatra. Physical Geology

CRYSTALLOGRAPHY AND MINERAL SCIENCE

GL-404 **20+80 Marks**

Course Objective: The objective of the course is to make students appreciate the physical and optical characteristics of minerals.

UNIT – I **(25)**

Symmetry operations, Space lattice, crystal imperfection, Twinning in crystal, stereographic projection of crystals, X-ray crystallography.

UNIT – II **(25)**

Physical properties of minerals, silicate structure, study of structure, chemistry, composition, physical & optical properties olivine, garnet, pyroxene & amphibole group of minerals.

UNIT – III **(25)**

Study of minerals structures, chemical composition, physical and optical properties of feldspars, feldspathoid, silica, mica, alumino-silicate and carbonate group.

UNIT – IV **(25)**

Polarization, Nicol prism: principle, construction and uses; preparation of thin section; Behavior oh light in thin section, accessory plates, extinction, interference color, Pleochroism, Parts and function of polarizing microscope. Uniaxial interference figure, Bi-axial interference figure; Refractometry: measurement of index refraction, dispersion, elementary idea on universal stage, outline study of optical properties of minerals studied under microscope.

Course Outcome: Upon successful completion of this course, the students will gain the fundamental understanding on Crystal, its packing, space lattice and the symmetry operation that forms the basis for many crystal structures. The course provides a broad introduction to silicate and non-silicate minerals, its structure, chemical composition, physical properties and their classification and how they depict the variedness of their formational environment. From this course students learned to identify the minerals both in the field and from hand samples and thin sections. The course has a very good potential to make the students amply sought after w.r.t. gemstone industry after their successful completion.

Selected Readings:

1. **Phillips, F.C.** An introduction to crystallography, john wiley& sons
2. **Berry Masson**. An introduction to Minerology
3. **William, D. Nesse** Introduction to minerology

STRUCTURAL GEOLOGY AND TECTONIC

GL-406 **20+80 Marks**

Course Objective: The objective of the course is to help students understand the deformational characteristics of various rock types and strata.

UNIT – I **(25)**

Concept of stress and strain, altitude of beds, Deformation mechanism, relation between deformation and metamorphism, determination of strain in rocks. Elastic, Viscous and plastic models of rock behavior, factors controlling behavior of rocks materials upon deformation.

UNIT – II **(25)**

Ramsay's classification folds, mechanism of folding, recognition of folds; classification of faults mechanism of faulting; recognition of faults; joints, types of significance

UNIT – III **(25)**

Unconformity: Types, recognition in the field, Foliation: types and their relation major structure lineation: types and their relation to major structure lineation: types and their relation to major structure Shear Zones: concepts and types

UNIT – IV **(25)**

Top and bottom criteria; Salt dome, Rule of V's, Granite Tectonics, Tectonites: concept, type strain significance and plate tectonic environment of tectonite formation; structural analysis, Concept of Plate Tectonics; Geo-dynamic of Indian plate; Neotectonics movements; Tectonic design and evolution of Himalayas; tectonic control on genesis and location ores.

Course Outcome: The students will understand the basic concept of stress, strain, and rheology of Earth's lithosphere. They also learn the various deformation mechanisms like elastic, viscous and plastic models of rock behavior. They will gain a good understanding on broad range of geological structures like fault, fold, unconformities and its geometric description and classification. The course will educate the students on the aspect of how variability of environment brings about the changes in the rocks. Also, they will learn how to red simple geological map and cross sections. The course has a very good potential to make the students amply sought after w.r.t. environmental application & Petroleum industry after their successful completion.

Selected Readings:

8. **M. P. Billing** structural geology
9. **S. K. Ghosh** structural geology
10. **B. S. S. Narayan Swami** structural geology

RESEARCH METHODOLOGY

GL-408 **20+80 Marks**

Course objective: The objective of the course is to help students cognizant of the research methodologies and ethics therein.

UNIT – I **(25)**

Science and scientific methods; what is research? Types of research; Research methods and research methodology, Ethics in research; Different approaches to research, the research process; an eight steps models, review of literatures; formulating a research problem, identifying variables, constituting hypothesis, The research design; sampling basic descriptive statistics

UNIT – II **(25)**

Writing a research proposal, collecting data, processing data, displaying data, Report writing and oral presentation.

UNIT – III **(25)**

Role and components of field studies, equipment, Topographic maps, components of geological map, some field suggestions and precautions, field documentation, some field indicators of minerals, rocks and structures, Methods of geological mapping.

UNIT – IV **(25)**

Petrographical field features of rocks, Structural field features of rocks, data to be collected during geological mapping, Specimens and samples, symbols used in geological mapping, preparation of geological report.

Course Outcome: The student will be able to learn what is research, why it is needed in a scientific way, what are the methods used for and overall, the approaches in one or more subfields in Earth sciences. They also learn how to write the research proposal, outlines the types of data needed to meet the objectives and moreover the collection of raw data in the field and its experimental analysis in the laboratory. At the end of the course completion, they can be able to do the geological mapping independently or as part of a team and write the result as a technical reports/dissertation and present their research orally. The course has a very good potential to make the students amply sought after w.r.t. various Research organizations and in Academia after their successful completion.

Selected Readings:

1. **C.R. Kothari.** Research methodology
2. **N.W. Gokhale.** A manual of Problems in structural geology
3. **Angela.L. Coe** Textbook of geological field technique
4. **A.K Sen** Laboratory manual

PRACTICAL

GL-410 **100 Marks**

Course Objective: The objective of the course is to have the students have a hands-on experience with geological mapping.

1. Stereographic projection of crystals
2. Megascopic and microscopic identification of important rock forming minerals, measurement of extinction angle
3. Completion of outcrops
4. Drawing of geological section and interpretation
5. Use of sterionet in Solving structural problem
6. Thickness of beds, three-points problem rule of V's
7. Drawing of tectonic elements in maps of India and world
8. Feasibility of sites for dam, tunnel construction (map)
9. Engineering properties of rock and soil
10. Geological field report
11. Lab record and viva-voice

Course Outcome: The course deals with the hands-on experience of the students in relation to the knowledge acquired from the theoretical aspects of geologic structures and various earth systems. The course has a very good potential to enhance the skills of the students in geological mapping.

OPEN ELECTIVE
BASICS OF REMOTE SENSING

OE – GL – 412 **100 Marks**

Course Outcome:

UNIT – I **(25)**

Concept of remote Sensing; Remote sensing data collection; Remote Sensing: Art or Science; Information about an object or area; Distance: How far is Remote; Advantages and Limitations; Electromagnetic Spectrum, interaction with the Atmosphere.

UNIT – II **(25)**

The Remote Sensing Process: Active and Passive Remote Sensing, Orbits – Sun-synchronous and Geo-synchronous; Resolution – Spectral, Spatial, Radiometric, Temporal.

UNIT – III **(25)**

Elements of visual image interpretation: - Depth perception, Beyond human visual perception, Tone and Color, Size, Shape, Texture, Pattern, Shadow, Association; The Multi-concept.

UNIT – IV **(25)**

History of Remote sensing and Indian Space Program; LANDSAT program; Global Positioning system; Geographic Information System – The manager.

Course Outcome: This course is designed so that the students are equipped with the basic theory behind the tools as well as their practical application in real life to analyze and interpret our environmental processes to better manage and monitor it. It includes the fundamentals of Remote Sensing and how the satellite products / aerial photographs help us collect the varied spatio-temporal information in an unbiased manner. At the completion of the course the students will be cognizant of the various aspects of the Geospatial tools that we use in our day-to-day life and how it is enhancing the life of human beings in a significant way with respect to spatial and temporal aspects. The course has a very good potential to make the students amply sought after w.r.t. cartography and space science organizations and in Academia after their successful completion.

Selected Readings:

1. John R Jensen, Remote Sensing of the environment – An earth resource perspective, PEARSON New International Edition, Second Edition, Edinburgh, 619p.
2. Ravi P Gupta, Remote Sensing Geology, Springer, Second Edition, New York, 671p.

THIRD SEMESTER

ENVIRONMENTAL GEOLOGY AND DISASTER MANAGEMENT

GL-501 **20+80 Marks**

Course Outcome: The objective of the course is to make students appreciate the linkage between geology and our Mother Nature.

UNIT – I **(25)**

Dimension of environmental stress; Spectrum of environmental geology, soil erosion methods, soil conservation, soil hazard; desertification: cause and measure to combat desertification.

UNIT – II **(25)**

Impact of mining activities on environment, waste disposal, environmental effect of river valley project, effect of excessive withdrawal of ground water, urbanization and environment, nuclear waste disposal- geological constrain, marine pollution

UNIT – III **(25)**

Role of geologist in environmental planning and measurement, environmental protection and legislative measure, environmental pollution, alternative source of energy, utilization of fly ash, sustainable development.

UNIT – IV **(25)**

Meaning and concept of natural hazards, element of disaster management, method and approach of disaster management, role of science and technology in disaster risk reduction, climate change. Earthquake and its management, landslides and its management, coastal hazard and its management, flood and its management, anthropogenic disaster.

Course Outcome: The students will learn how different geologic and atmospheric processes responsible for earth degradation such as mining activities, waste disposal and causes various type natural hazards, including earthquakes, volcanic eruptions, landslides, flooding, tornadoes, hurricanes, tsunami etc. They will come to know the various risks obtain from of the disasters on ecological and societal consequences, and the role of human beings to mitigate the risk using different technology, making policy and proper planning and measurement. The course has a very good potential to make the students amply sought after w.r.t. tourism industry and non-Government-organizations their successful completion.

Selected Readings:

11. **D. S. Lal** A textbook of Climatology
12. **K. S. Valdiya** Environmental Geology
13. **S. Singh** Environmental Geography

STRATIGRAPHY AND PALAENTOLOGY

GL-503 **20+80 Marks**

Course Outcome: The objective of the course is to help students build paeo-environment and correlate the geologic strata w.r.t. time and space.

UNIT – I **(25)**

Principle of Stratigraphy, Stratigraphic correlation, code of stratigraphic classification and nomenclature, stratigraphic units, stratigraphic of Aravalli supergroup.

UNIT – II **(25)**

Stratigraphy of Gondwana Supergroup, Singhbhum Odisha province; Eastern ghat group Cuddapah supergroup, Vindhyan supergroup.

UNIT – III **(25)**

Stratigraphy of Gondwana Supergroup, Triassic of Spiti, Jurassic of Kutch, Cretaceous of Trichinopoly, Siwalik group, Tertiary of Assam, Decan Traps, Quaternary deposits Geology and Stratigraphy of Odisha

UNIT – IV **(25)**

Models of preservation of fossils, utility of fossils; morphology, evolution, geological history of Brachiopoda, Pelecypoda, Gastropoda, Trilibite and Echinoidea. Morphology and geological history of Graptolite, Coral; Organic evolution: concept, theories and evidence; evolution of Horses & man; Extinctions of Dinosaurs; morphology of Foraminifera and their significance; Gondwana flora and their significance.

Course Outcome: The students will learn the principles and techniques used to study historical geology and able to understand the underlying principles in the study of stratigraphic record, viz. chrono, litho and bio stratigraphy and the concept of lithofacies and biofacies. They also learn to identify various common fossils and describe their habitat, evolution and significance in geological history. This course emphasizing on the stratigraphy, paleoclimatic, tectonic and biological history of the Indian subcontinents with a special focus on Odisha. The course has a very good potential to make the students amply sought after w.r.t. Petroleum industry, Research organizations and in Academia after their successful completion.

Selected Readings:

14.	**Rabindra Kumar**	Fundamentals of historical geology and stratigraphy of Odisha
15.	**M.K.Krishnan**	Geology of India and Burma
16.	**D.N. Wadia**	Textbook of stratigraphy of India
17.	**M.S. Anantharaman**	Paleontology
18.	**Shorck and Twinhofel**	Introduction to paleontology

ORE GEOLOGY

GL-505 **20+80 Marks**

Course Outcome: The objective of the course is to help student understand the genesis of ore deposits.

UNIT – I **(25)**

Magmatic Concentration Process. Hydrothermal process. Oxidation and Sulphide Supergene Enrichment process. Residual and Mechanical concentration Process. Classification of Mineral Deposits.

UNIT – II **(25)**

Porphyry Deposits. Skarn Deposits. Volcanic associated Massive Sulfides (VMS) deposits. Sediments Hosted Massive Pb-Zn deposits. Sediment hosted stratiform (SHS) Cu-deposits. Pre-Cambrian Iron formation. Uranium deposits. Gold Deposits. Marine Mineral Resources, Manganese Nodules.

UNIT – III **(25)**

Geological method of mineral exploration. Geochemical method of mineral Exploration. Geophysical method of mineral Exploration. Methods of Sampling. Ore Reserve Estimation. Fluid Inclusion studies. Geothermometry. Wall rock Alteration. Paragenisis. Control of Ore localization.

UNIT – IV **(25)**

Component of ore microscope. Preparation of Polished section. Physical and optical characters of ore minerals studied under microscope. Ore texture and structures. Ore minerals studied under microscope chalcopyrite-Galena-Pyrite-Pyrolusite-Psilomelane-magnetite-Hematite- Chromite and Sphalerite.

Course Outcome: The students will learn how different process of fluids and melts get enrichment by valuable element that subsequently causes to deposits the ore bodies. They will learn to get familiar with a wide range of mineral deposit environment. This includes including recognizing the overall geometry, zonation and alteration patterns associated with specific classes of metallic mineral deposits. They also learn the technique used for mineral prospecting and extraction. The students will be able to recognize common ore minerals in hand samples and under the microscope. The course has a very good potential to make the students amply sought after w.r.t. Mining Industry after their successful completion.

Selected Readings:

19. Jensen and Batman — Economic mineral deposits
20. A.K.Sen and P.K.Guha — A hand book of economic Geology
21. Sinha and Sharma — Mineral economics
22. S.K. Tiwari, — Ore geology, Economic mineral and mineral economics

Elective: The students can opt for any one group (either Group-A or Group-B) for elective-I and elective-II. Number of contact periods per week: 1hours for each credit.

Elective-I
APPLIED HYDROGEOLOGY (Group-A)

GL-507 **20+80 Marks**

Course Objective: The objective of the course is to make student cognizant of the dynamics of groundwater flow and chemistry.

UNIT – I **(25)**

Hydrological cycle. Vertical Distribution of Subsurface water. Properties of water bearing Formation. Types of Aquifers. Darcy's Law. Geomorphic and Geologic controls on Groundwater. Water level Fluctuation.

UNIT – II **(25)**

Quality of Ground water and its uses in domestic and irrigational field. Ground water pollution and legislation. Sea water Intrusion. Consequences of excessive withdrawal of Groundwater, Hydro chemical provinces of India.

UNIT – III **(25)**

Ground water Exploration. Objective and methods (Geological, geophysical and Hydrological) Drilling Methods; Types of wells; failure of Tube wells. Ground water development and management.

UNIT – IV **(25)**

Brief Idea on Thermal springs of Odisha. Groundwater Provinces of Odisha. Fluorosis Problem in Odisha. Ground water Provinces of India. Problem of Iron Pollution in drinking water of Odisha. Fluoride Problem in Groundwater. Arsenic Problem in Ground water. Hydrological Research in India. Hydrological Setting of India. Groundwater occurrence, movement Aquifer Characteristics in consolidated Formation. Watershed Management. Impact of Climate change on global Groundwater resources.

Course Outcome: The students will come to learn the physical environment that control the flow of water in the subsurface, transport and storage of the groundwater and properties of different water bearing formations. They also gain the understanding to evaluate groundwater quality and quantity for water supply, irrigation, and industrial purposes for use in a sustainable way. It aims to give students a sound understanding on topics related to hydrogeology in groundwater exploration, methods of drilling, ground water development, resource management and remedies required for wastewater and mine drainage management. The course has a very good potential to make the students amply sought after w.r.t. various Water Research organizations after their successful completion.

Selected Readings:

23. D.K. Todd Hydrology
24. H.M. Raghunath Hydrology
25. K.R. karantha Hydrogeology

ELECTIVE-I (GROUP-B)
COAL & PETROLEUM GEOLOGY

GL-507 **20+80 Marks**

Course Objective: The objective of the course is to help student appreciate the dynamics of coal and petroleum deposits.

UNIT – I **(25)**

Introduction, Uses of Coal, Rank of Coal, Chemical Properties. Classification of coal. Mode of occurrence of coal, Geological formation of Coal Deposits.

UNIT – II **(25)**

Fundamentals of Coal Petrography, Macroscopic and Microscopic constituents of coal. Coal Sampling and Analysis. Geology and coal mining, Coal Environment.

UNIT – III **(25)**

Coal as an alternative source of energy. Hydrogeology of Coal, Coal resources of India. Lignite resources of India.

UNIT – IV **(25)**

Introduction, Uses of Petroleum, Reservoir rocks, Origin of Petroleum, Oil traps, Composition of crude oil, Natural Gas. Distribution of Oil and gas. Sources of Mineral oil. Oil Shale. Black Shale. Coal Bed Methene (CBM). Oil from plants. Petroleum and environment. Petroleum exploration.

Course Outcome: The students will acquire knowledge on the environment of formation of coal and petroleum, its chemical and physical properties and occurrences in different geological formations. They also learn the methods of extraction of coal by either surface or underground mines and how different geological problems and environmental issues affect the exploration of petroleum and natural gas and surrounding mining areas. They will gain knowledge regarding different sources of mineral oil, oil shale, Black Shale and Coal Bed Methane. The course has a very good potential to make the students amply sought after w.r.t. Mining Industry after their successful completion.

Selected Readings:

26. A.L. Levorsen Geology of Petroleum
27. Larry Thomas Coal Geology

COAL & PETROLEUM GEOLOGY/
MINING AND MINERAL ECONOMICS
ELECTIVE-I&II (GROUP-A)

GL-509 **100 Marks**

Course Objective: The objective of the course is to make students cognizant of coal and petroleum deposits, their formation and intricate relationship with our environment.

1. Identification coal, coal petrography
2. Plotting of places of coal fields and oil fields in the map of India.
3. Ore reserve estimation problem
4. Problem relating to grade and assay value
5. Lab record and viva-voce

Course Outcome: The course deals with the hands-on experience of the students in relation to the knowledge acquired from the theoretical aspects of coal and mining geology. The course has a very good potential to enhance the skills of the students in coal/mineral exploration.

HYDROLOGY/RS & GIS
ELECTIVE-I&II (GROUP-B)

GL-509 **100 Marks**

Course Objective: The objective of the course is to enable the students with environmental management based on geospatial techniques.

1. Simple numerical problem related to hydrology.
2. Problem related to groundwater quality.
3. Electrical resistivity survey and data interpretation.
4. Well inventory data generator and interpretation.
5. Ground water resource estimation and budgeting.
6. Fence diagram
7. Ground water maps, water table contour maps
8. Problem relating to RS & GIS
9. Preparation of thematic maps using RS & GIS
10. Lab record and viva-voce.

Course Outcome: The course deals with the hands-on experience of the students in relation to the knowledge acquired from the theoretical aspects of geologic mapping and cartography. The course has a very good potential to enhance the skills of the students in geospatial analysis.

FOURTH SEMESTER

ECONOMIC MINERAL DEPOSITS

GL-502 **20+80 Marks**

Course Objective: The objective of the course is to make students appreciate the dynamics of various economic mineral deposits and their impact on environmental sustainability.

UNIT – I **(25)**
Mineralogy, Mode of occurrence, Distribution and uses of iron ores, manganese ores Coppers and Pb and Zn ores.

UNIT-II **(25)**
Mineralogy, mode of occurrence, distribution and uses of chromite, Bauxite, Gold, Mica and Graphite and Asbestos.

UNIT – III **(25)**
Mineralogy, mode of occurrence, distribution and uses Kyanite, Sillimanite, Limestone, Magnesites, and Uranium & Thorium deposits of India. Coal: Origin of coal; Coal and lignite resources of India; Coal petrography Petroleum Origin of petroleum, petroleum resources of India, Petroleum exploration.

UNIT – IV **(25)**
An outline of mineral resources of Odisha, East coast Bauxite, Sukinda Chromite deposits, Mn –deposits of Jamda-Koira valley, Talcher Coal field, Ib-valley coal field heavy minerals of Ganjam coast, gemstone resources of Odisha.

Course Outcome: The students will come to learn the mineralogy, mode of occurrence, distribution and the uses of common metallic ore deposits and the fossil fuels. This course also emphasizing on the stratigraphy, structure and metallic mineral resources of the Indian subcontinents with a special focus on Odisha. At the end of this course completion, they will recognize the common ore minerals in hand samples and their optical properties under the microscope. The course has a very good potential to make the students amply sought after w.r.t. Mining Industry after their successful completion.

Selected Readings:

1. **Umeswar Prsad** Economic geology
2. **A.K.Sen and P.K.Guha** A hand book of economic Geology
3. **S.K. Tiwari** Ore geology, Economic mineral and mineral economics
4. **R.N.P. Arogyoswami** Mining economics
5. **S.Deb** Industrial minerals

Elective: The students can opt for any one group (either Group-A or Group-B) for elective-I and elective-II. Number of contact periods per week: 1hours for each credit.

ELECTIVE-II (GROUP-A)
REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM (GIS)

GL-504 **20+80 Marks**

Course Objective: The objective of the course is to help student appreciate the basics of geospatial science and its application in environmental management.

UNIT – I **(25)**

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 **(25)**

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 **(25)**

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 **(25)**

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.

Course Outcome: The students will acquire knowledge on the fundamentals and theories of remote sensing, role of electromagnetic spectrum, digital cartography, and geographic information systems (GIS). They also learn to analyze spatial data using GIS analysis tools, creates map, images and apply the knowledge in studying different geoscientific fields. The course has a very good potential to make the students amply sought after w.r.t. various Space Research organizations and GIS Industry after their successful completion.

Selected Readings:

1. D. Chakrabraty and R.N. Sahoo Fundamental of GIS
2. D. Nandi and T. Chatterjee A textbook of remote sensing and cartography

ELECTIVE-II (GROUP-B)
MINING, MINERAL ECONOMIC AND ENGINEERING GEOLOGY

GL-504 **20+80 Marks**

Course Objective: The objective of the course is to make students aware of the various aspects of mining geology and its intricate interrelationship with environment.

UNIT – I **(25)**

Mining Terminology, Open Cast mining method, Underground mining methods, Coal Mining methods, Drilling methods.

UNIT – II **(25)**

Ore Dressing Techniques. Ancillary operation in Prospecting. Impact of mining activities on environment. Mineral and mineral based industries of Odisha.

UNIT – III **(25)**

Minerals and the Economy. National mineral policy Mine Taxation Mine finance and Accounting. Valuation of mineral Properties and Project Evaluation.

UNIT – IV **(25)**

Mines sampling. Ore Reserve Estimation. Reserve-Resource Dynamic. Mineral Inventory, Co-Product and By-Product. Conservation of Mineral Resources. Mineral base Based Industries in Odisha. Iron & steel Industries, Aluminum Industries, Fertilizer Industry, Re-factory Industries, Cement Industries.

Course Outcomes: The students will learn the technique used for mineral prospecting, exploration, mine development, and mineral treatment. They will come to learn the use of this mineral resources and how these will help contribute the development of the industries as well as the nation. They will gain knowledge regarding the mineral-based industries with a special focus on Odisha. The course has a very good potential to make the students amply sought after w.r.t. Mining Industry after their successful completion.

Selected Readings:

3. **Umeswar Prsad** Economic geology
4. **A. K. Sen and P. K. Guha** A handbook of economic Geology
5. **S. K. Tiwari** Ore geology, Economic mineral and mineral economics
6. **R.N.P. Arogyoswami** Mining geology
7. **S. Deb** Industrial minerals
8. **Shinha and Sharma** Mineral economics

COAL & PETROLEUM GEOLOGY/
MINING AND MINERAL ECONOMICS
ELECTIVE-I&II (GROUP-A)

GL-506 **100 Marks**

Course Objective: The objective of the course is to give students a hands-on experience on mining of mineral deposits.

6. Identification coal, coal petrography
7. Plotting of places of coal fields and oil fields in the map of India.
8. Ore reserve estimation problem
9. Problem relating to grade and assay value
10. Lab record and viva-voce

Course Outcome: The course deals with the hands-on experience of the students in relation to the knowledge acquired from the theoretical aspects of coal and mining geology. The course has a very good potential to enhance the skills of the students in coal/mineral exploration.

HYDROLOGY/RS & GIS
ELECTIVE-I&II (GROUP-B)

GL-506 **100 Marks**

Course Objective: The objective of the course is to give hands-on experience to students on how geospatial technology is used for environmental management and monitoring.

11. Simple numerical problem related to hydrology.
12. Problem related to groundwater quality.
13. Electrical resistivity survey and data interpretation.
14. Well inventory data generator and interpretation.
15. Ground water resource estimation and budgeting.
16. Fence diagram
17. Ground water maps, water table contour maps
18. Problem relating to RS & GIS
19. Preparation of thematic maps using RS & GIS
20. Lab record and viva-voce.

Course Outcome: The course deals with the hands-on experience of the students in relation to the knowledge acquired from the theoretical aspects of geologic mapping and cartography. The course has a very good potential to enhance the skills of the students in geospatial analysis.

DISSERTATION

GL-508 **100 Marks**

Course Objective: The objective of the course is to make students use the geological knowledge gathered through the programme to carry out a pilot project by all the principles taught.

Course Outcome: The course deals with the hands-on experience of the students in relation to the knowledge acquired from the theoretical aspects throughout the programme. The course will enable the students to put into effect all the knowledge they have gained in the field, collect sample specimens from the field and analyze them in the laboratory. The course has a very good potential to enhance the skills of the students to analyse geological processes and their manifold interpretations to appreciate existing earth science systems.