

REGULATIONS & SYLLABUS

(Revised for Admission Batch 2021-23)

**MASTER OF SCIENCE
in
GEOLOGY**



**P.G. Department of Geology
Fakir Mohan University
Vyasa Vihar, Balasore – 756089
2021-22**

**FAKIR MOHAN UNIVERSITY, M.Sc. GEOLOGY EXAMINATION
CHOICE BASED CREDIT SEMESTERSYSTEM**

Examination Schedule: 1st Semester-December/January
2nd Semester-May/June
3rd Semester- December/January
4th Semester-May/June

1. Candidates with at least 2nd class honours in B.Sc. Geology are eligible to apply for admission into the course.
2. 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 40 marks and end term is 60 marks in each semester.
3. **The 40 internal marks in each paper comprising of**
 - a. **10 marks Quiz test (01) from 1st Unit,**
 - b. **20 marks midterm Exam (01) from 1st and 2nd unit,**
 - c. **10 marks Quiz test (02) from 3rd Unit,**
 - d. **10 marks assignment from 4th Unit.**

N.B. The best mark out of the two quiz tests will be considered.

4. The end term examination will be from all units with 60 marks in each paper.
5. The duration of the theory examination will be 3 hours. Practical papers will be of 70 marks and the duration of examination will be 6 hours. Rest 30 marks will be for seminar presentation in each semester (up to 3rd semester). Students must present minimum 03 presentations in seminar. There will be a dissertation/ project of 30 marks in 4th semester.
6. 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, the Semester (Theory and Practical) examinations of the session will be conducted as per the directions of the university administration.
7. The Semester system of Examination will have internal as well as external valuation for theory papers. Practical papers will be examined by one internal examiner and one external examiner.
8. 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.
9. In third semester, the students have to opt for one CBCS paper from other departments.
10. **The paper GL403 will carry 200 marks for Project/ Dissertation work.**
11. In each year, the students are required to undergo a Field Training programme for a period of up to 15 days. The students need to deposit a requisite fee towards the field training programme. It is mandatory for the students to submit the field report at the department within 15 days of the completion of the field training.

M.Sc. GEOLOGY

SEMESTER I

PAPER CODE	PAPER NAME	MARKS					Credit
		End term Mark	Internal Mark			TOTAL	
			Quiz test	Mid term	Assign-ment		
GL101	Crystallography and Mineralogy	60	10	20	10	100	04
GL102	Geochemistry and Isotope Geology	60	10	20	10	100	04
GL103	Structural Geology	60	10	20	10	100	04
GL104	Geomorphology & Global Tectonics	60	10	20	10	100	04
GL105	Geology Lab-I						
	a) Practical related to Papers GL 101 & GL 102	35	-			100	03
	b) Practical related to Papers GL 103 & GL 104	35	-				03
	Seminar	-	30				02
TOTAL						500	24

SEMESTER II

PAPER CODE	PAPER NAME	MARKS					Credit
		End term Mark	Internal Mark			TOTAL	
			Quiz test	Mid term	Assign-ment		
GL201	Igneous Petrology	60	10	20	10	100	04
GL202	Sedimentology and Fuel geology	60	10	20	10	100	04
GL203	Metamorphic Petrology	60	10	20	10	100	04
GL204	Oceanography, Atmospheric Science and Disaster Management	60	10	20	10	100	04
GL205	Geology Lab-II						
	a) Practical related to Papers GL 201 & GL 202	35	-			100	03
	b) Practical related to Papers GL 203 & GL 204	35	-				03
	Seminar	-	30				02
TOTAL						500	24

SEMESTER III

PAPER CODE	PAPER NAME	MARKS				TOTAL	Credit
		End term Mark	Internal Mark				
			Quiz test	Mid term	Assign-ment		
GL301	Palaeontology and Quaternary Geology	60	10	20	10	100	04
GL302	Stratigraphy	60	10	20	10	100	04
GL303	Economic geology	60	10	20	10	100	04
GL304	General Geology & Mineral resources of Odisha (CBCS paper for other P.G. departments)	60	10	20	10	100	04
GL305	Geology Lab-III						
	a) Practical related to Papers GL 301 & GL 302	35	-			100	03
	b) Practical related to Paper GL 303	35	-				03
	Seminar	-	30				02
TOTAL						500	24

SEMESTER IV

PAPER CODE	PAPER NAME	MARKS				TOTAL	Credit
		End term Mark	Internal Mark				
			Quiz test	Mid term	Assign-ment		
GL401	Groundwater & Engineering Geology	60	10	20	10	100	04
GL402	Remote Sensing, GIS and Geostatistics	60	10	20	10	100	04
GL403	Dissertation	200				200	08
GL404	Geology Lab-III						
	Practical related to Papers GL 401 & GL 402	70	-			100	06
	Seminar Presentation		30				02
TOTAL						500	24

Semester I

Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL101	Crystallography and Mineralogy	4	40	60

Objectives	The basic objective of this course is to introduce students the ideas and techniques of analyzing crystal models to unearth the minerals with respect to its several properties and classes.
Pre-Requisites	Knowledge related to basics of crystals and minerals
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with focus on problem solving and practical activities.

Detailed Syllabus

Unit	Topics	Hours
I	Crystallography, Unit cells, Concept of lattice network, Bravais lattices, X-ray study of crystals, Crystal Symmetry and Millers Indices, Hermann Mauguin system of crystal notation.	10
II	Pauling's rules and coordination polyhedra; Zone and zonal laws; Crystal imperfection, Twinning, Polarisation, pleochroism, pleochroic scheme, isotropism and anisotropism,	09
III	Double refraction, birefringence, behavior of isotropic and anisotropic minerals under polarized light, interference colour, uniaxial and biaxial interference figures; optic axial angle, extinction angle.	09
IV	Structural classification of silicates, Physico-chemical and optical properties and occurrence of Silicate Mineral groups- Feldspar, Olivine, Garnet, Pyroxene, Amphibole, Mica, Silica.	10
V	Physical, chemical, optical properties and occurrence of Non-silicate mineral groups- Native elements, Oxides, Carbonates, Sulphides, Phosphates and Halides.	10
Total		48

Reference Books:

- R1. Berry, L.G., Mason, B. and Dietrich, R.V. (1985) Mineralogy: Concepts, Descriptions and determinations. CBS Publishers
- R2. Bloss, F.D. (1971): Crystallography and Crystal Chemistry, Holt, Rinehart, and Winston, New York
- R3. Dana, E.S. and Ford, W.E. (2002) A textbook of Mineralogy (Reprint) Deer, W.A., Howie, R.A. & Zussman, J. (2013): An Introduction to the rock forming minerals, ELBS and Longman
- R4. Gribble C.D. (2005) Rutley's elements of Mineralogy, Springer.
- R5. Kerr, P.F (1977): Optical Mineralogy McGraw Hill
- R6. Nesse, D.W (1986): Optical Mineralogy, McGraw Hill
- R7. Perkins, D. (2013) Mineralogy, Prentice Hall
- R8. Phillips, F.C (1971) Introduction to Crystallography. Longman Group Publication.

Course Outcome	At the end of the course, the students will be able to: <ol style="list-style-type: none"> i) Explore different tasks related to crystal models ii) Differentiate the mineral properties and classes
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Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL102	GEOCHEMISTRY AND ISOTOPE GEOLOGY	4	40	60

Objectives	The basic objective of this course is to bring together the ideas of geochemistry and isotope geology for unraveling the earth layers and the elements present
Pre-Requisites	Knowledge of chemical elements
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with several models

Detailed Syllabus

Unit	Topics	Hours
I	Origin of chemical elements, solar system and earth, abundance of elements in cosmos, Distribution of elements in core, mantle, crust, hydrosphere and atmosphere, Internal structure of the earth, Geochemical cycle, Geochemical differentiation.	10
II	Geochemical classification of elements. Isomorphism, Polymorphism, Atomic substitution, Geochemistry of igneous and metamorphic processes. Distribution coefficients and determination of Pressure and Temperature conditions.	09
III	Trace element geochemistry. Geochemistry of weathering, transportation and deposition. Study of Eh-pH diagram. Petrography of lunar rocks and meteorites.	09
IV	Radioactivity. stable and radiogenic isotopes, Dating Methods, Interpretation and geological significance of ages. Isotope systematics of K-Ar, Rb-Sr, Sm-Nd, U-Th-Pb in igneous, metamorphic and sedimentary rocks and in evolution of ocean, crust and mantle	10
V	Stable isotopes of Oxygen and Hydrogen, Carbon, Nitrogen and Sulphur. Fractionation of stable isotopes. Stable isotope geothermometry and geobarometry.	10
Total		48

Reference Books:

- R1. Alan P. Dickins (2005) Radiogenic Isotope Geology, Cambridge University Press.
- R2. Hoefs, J. (1980): Stable Isotope Geochemistry, Springer and Verlag.
- R3. Hugh R. Rollinson (2007) Early Earth Systems: A Geochemical Approach by Blackwell Publishing Ltd.
- R4. Gunter Faure (1977) Principles of Isotope Geology by John Wiley & Sons Ltd.
- R5. Hugh R. Rollinson (1993) Using Geochemical Data: Evaluation, Presentation and Interpretation, Pearson Prentice Hall.
- R6. Albarde Francis (2003): Geochemistry- Introduction. Cambridge University Press.
- R7. Kula C Misra (2012) Introduction to Geochemistry: Principles and Applications, Wiley-Blackwell.

Course Outcome	At the end of the course, the students will be able to: <ol style="list-style-type: none"> i) Elementary idea related to different layers of earth with respect to its chemical constituents ii) Establish knowledge on radioactivity iii) Explore the different isotopes
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Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL103	STRUCTURAL GEOLOGY	4	40	60

Objectives	The basic objective of this course is to introduce students the concepts of rock structure and its significance
Pre-Requisites	Knowledge of different types of rocks and its formation
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with presentation of related models followed by field studies

Detailed Syllabus

Unit	Topics	Hours
I	Concept of stress and strain. Two-dimensional stress and strain analyses. Mohr's circle. Types of strain ellipsoids and their geological significance. Strain analysis of naturally deformed rocks.	10
II	Geometry and classification of folds. Mechanics and dynamics of folding. Evidence of buckling. Superposed folding and interference pattern. Distribution of strains in folds, Salt dome.	10
III	Classification of faults. Features associated with normal faults, strike-slip faults, overthrusts and nappes. Causes and dynamics of faulting. Recognition criteria of faulting. Classification of joints. Joint related structures. Analysis of joints and their tectonic significance.	08
IV	Classification and geometry of different types of shear zones. Strain variation in shear zones. Shear sense indicators. Time relationship between crystallization and deformation.	10
V	Foliation and Lineation: Morphology and types of foliations and lineations. Significance of linear structures. Geometry and development of boudinage structures. Tectonites. Types of unconformities, their recognition criteria. Importance of unconformity	10
Total		48

Reference Books:

- R1. Turner, F.J. and Weiss, L.E. (1963): Structural analysis of Metamorphic Tectonites McGraw Hill.
- R2. Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Developments. Pergamon Press.
- R3. Ramsay, J.G. and Huber, M.I. (1983): Techniques of Modern Structural Geology. Vol. I. Strain Analysis. Academic Press.
- R4. Ramsay, J.G. and Huber, M.I. (1987): Techniques of Modern Structural Geology. Vol. II. Folds and Fractures. Academic Press.
- R5. Twiss, R.J. and Moores, E.M. (2006): Structural Geology Second Edition, W. H. Freeman
- R6. Fossen, H. 2010: Structural Geology, Cambridge University Press:
- R7. Marshak S and Mitra, G (1988): Basic Methods of Structural Geology, Prentice Hall

Course Outcome	At the end of the course, the students will be able to: i) Explore different rock structures and its fame ii) Explore the different skills to identify the rock structure
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Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL104	GEOMORPHOLOGY & GLOBAL TECTONICS	4	40	60

Objectives	The basic objective of this course is to introduce different landforms and its formation mechanism with significance and also present the ideas related to tectonics.
Pre-Requisites	Knowledge of several agents of transportation and deposition and tectonic plates
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with focus on model presentation

Detailed Syllabus

Unit	Topics	Hours
I	Geomorphic principles and processes, Weathering and associated landforms, erosion, Karst topography, soil profile, classification of soils, Geomorphic sub-divisions of India and Odisha.	11
II	Fluvial processes and landforms, regime concept, Drainage Analysis, Aeolian processes and landforms, Glacial processes and landforms, Coastal processes and landforms.	10
III	Theory of isostasy, Concept of plate tectonics. mechanism of plate tectonics, Types of plate boundaries. Characteristic features of accretionary, conservative and destructive boundaries.	09
IV	Mid-oceanic ridges. Sea-floor spreading. Continental rifting, transform faults, Island arcs, Geosynclines and mountain building activity.	08
V	Implications of plate tectonics: Environmental Change, Economic mineral deposits, Natural Hazards; Configuration of Indian plate, Evolution of the Himalaya and Himalayan tectonics.	10
Total		48

Reference Books:

- R1. Thornbury, W.D. 2004: Principles of Geomorphology. 2nd edition CBS Publication.
- R2. Summerfield M.A 2011: Geomorphology and Global Tectonics, Wiley India Pvt Ltd.
- R3. Gautam, A. 2015 : Geomorphology 5th Edition. Sharda Pustak Bhavan Allahabad.
- R4. Siddhardha, K. 2016 : The Earth's Dynamic Surface- A book of Geomorphology, Kitab Mahal
- R5. Singh Savindra 2016 : Geomorphology. Pravalika Publication Allahabad
- R6. Condie, Kent. C. 1989. Plate Tectonics and Crustal Evolution. 3rd Edition. Butterworth-Heinemann Ltd.
- R7. Windlley B. 1995: The Evolving Continents. 3 rd Edition Wiley-Blackwell.
- R8. Davies, G.F. 1999: Dynamic Earth: Plates, Plumes and Mantle Convection. Cambridge University Press.
- R9. Kearey P, Klepeis, K A and Vine, F.J 2009: Global Tectonics 3rd Edition. Wiley-Blackwell.

Course Outcome	At the end of the course, the students will be able to: <ol style="list-style-type: none"> i) Differentiate different landforms and its origin of formation ii) Signify the importance of each landform iii) Unravel the significance and mechanism of plate movement
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Sub. Code	Subject Name	Marks	Total	Credit
GL105	GEOLOGY LAB I		70	6
	(a) Practical related to Papers GL 101, GL102	35		
	(b) Practical related to Papers GL 103, GL 104	35		
	Seminar	30	30	2

Detailed Syllabus

Unit	Topics	Hours
I	Identification of crystal models as per theory, Stereographic Projection of crystals, Axial ratio determination. Megascopic and Microscopic identification of rock forming minerals. Determination of sign of elongation, Extinction angle, scheme of pleochroism, Order of interference colours, Optic sign. Calculation of mineral formulae from chemical data.	54
II	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 – π and β diagrams. Plotting of line and planes, problems relating to true and apparent dips, plunge and pitch, angle between planes and lines. Completion of outcrop; Study and interpretation of structural maps. Contouring of land forms, Toposheet studies, Slope and drainage analysis, Morphotectonic analysis.	54
III	<i>Laboratory records and viva voce.</i>	
	Total	108

SEMESTER II

Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL201	Igneous Petrology	4	40	60

Objectives	The basic objective of this course is to introduce students the detail idea related to igneous rocks formation, texture, structure and its types
Pre-Requisites	Knowledge of igneous rock analysis
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with focus on field based knowledge

Detailed Syllabus

Unit	Topics	Hours
I	Viscosity, temperature and pressure relationships in magmas; Classification of igneous rocks; nucleation and growth of minerals in magmatic rocks, development of igneous textures; structure.	12
II	Magmatic differentiation, assimilation, mixing and mingling; types of mantle melting (batch, fractional and dynamic).	08
III	Binary phase diagram and ternary (diopside-forsterite-silica, diopside-forsterite-anorthite and nepheline-kalsilite-silica) phase diagrams and relevance to magmatic crystallization.	08
IV	Petrology and petrogenesis of Granites, Basalts, Ophiolite suite, Komatiites, Syenites, Boninites, Anorthosites and layered complexes, and Alkaline rocks (Carbonatite, Kimberlite, Lamproite, Lamprophyre).	10
V	Mantle metasomatism, hotspot magmatism and large igneous provinces of India: Deccan trap, Singhbhum Granite. Inter-relation between tectonic setting and igneous rock suits.	10
Total		48

Reference Books:

- R1. J.D. Winter (2010) Principles of Igneous and Metamorphic Petrology, Pearson Prentice Hall.
- R2. Robin Gill (2010) Igneous Rocks and Processes: a practical guide. John Wiley & Sons.
- R3. Gautam Sen (2014) Petrology: Principles and Practice, Springer-Verlag publisher.
- R4. A. Philpotts and J. Ague (2009) Principles of Igneous and Metamorphic Petrology, Cambridge University Press.
- R5. K.G. Cox, J.D. Bell and R.J. Pankhurst (1979) . The Interpretation of Igneous Rocks Chapman and Hall publishing
- R6. M. Wilson (1989) Igneous Petrogenesis: A Global Tectonic Approach. Chapman and Hall publishing
- R7. B.R. Frost and C.D. Frost (2014) Essentials of Igneous and Metamorphic Petrology Cambridge University Press.

Course Outcome	At the end of the course, the students will be able to: <ol style="list-style-type: none"> i) Explore different igneous rocks ii) Composition, temperature and pressure condition of igneous rocks iii) Differentiate between igneous rocks of several era
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Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL202	Sedimentary Petrology and Fuel Geology	4	40	60

Objectives	The basic objective of this course is to introduce students the ideas of formation, texture and structure of sedimentary rocks and its analysis with study of fuel geology
Pre-Requisites	Knowledge of sedimentary rock types
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with focus on field-based studies

Detailed Syllabus

Unit	Topics	Hours
I	Sedimentary textures, sedimentary structures; Sedimentation processes, principles and application of paleocurrent analysis, bed load and suspension load transport; Element of Hydraulics.	08
II	Classification of sedimentary rocks. Composition, classification and significance of different types of Sandstone, Limestone, Banded Iron Formation, Mudstone, Conglomerate; Carbonate diagenesis and dolomitisation, Sedimentary Provenance	10
III	Study of heavy minerals and their significance, sedimentary environments and facies, sedimentation in major tectonic settings; Sequence stratigraphy, Basin Analysis: Concepts, Methods and Applications, Sedimentary basins of India	09
IV	Origin and classification of coal, Rank of coal, Proximate and ultimate analyses of coal, Microscopic constituents of coal, Coal carbonization, Hydrogenation, Liquefaction and gasification, Environmental impact of coal mining, Coal bed Methane, coal deposits of India.	10
V	Origin, migration and entrapment of natural hydrocarbons, mode of occurrence of petroleum, seepages, oil shale or kerogen shale, structural, stratigraphic and mixed traps; Reservoir rocks, pore space, Methods of Petroleum Exploration. Petroleum deposits of India. Gas hydrate.	11
Total		48

Reference Books:

- R1 Blatt, H., Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks, Prentice-Hall Inc.
- R2 Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
- R3 Collins, J.D., and Thompson, D.B. (1982): Sedimentary Structures. George Allen & Unwin, London.
- R4 Gary Nichols (2013) Sedimentology and stratigraphy. 2nd Edition Wiley-Blackwell.
- R5 Lindholm, R.C. (1987) A Practical Approach to Sedimentology. Allen & Unwin, London.
- R6 Pettijohn, F.J. (1975): Sedimentary Rocks. 3rd Edn. Harper and Row Publ., New Delhi.
- R7 Reading, H.G. (1997): Sedimentary Environments and facies, Blackwell Scientific Publication.
- R8 Selley, R. C. (2000) Applied Sedimentology, Academic Press.
- R9 Sengupta, S.M. (2018) Introduction to Sedimentology. CBS Publication, New Delhi.
- R10 Tucker, M.E. (1981): Sedimentary Petrology: An Introduction, Wiley & Sons, New York.

Course Outcome	At the end of the course, the students will be able to: <ul style="list-style-type: none"> i) Explore types of sedimentary rocks ii) Analyze sedimentary rocks and its significance iii) Importance of coal and petroleum with respect to mode of formation
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Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL203	Metamorphic Petrology	4	40	60

Objectives	The basic objective of this course is to represent the process and tectonism of formation of metamorphic rocks related to several attributes
Pre-Requisites	Knowledge of types of metamorphic rocks and their formations
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with focus on field-based studies

Detailed Syllabus

Unit	Topics	Hours
I	Limits and physico-chemical controls (pressure, temperature, fluids and bulk rock composition) of metamorphism; Types of metamorphism.	07
II	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.	11
III	Concept of zones, facies, isograds and facies series, geothermal gradients and tectonics of orogenic belts; structures, micro-structures and textures of regional and contact metamorphic rocks; representation of metamorphic assemblages (ACF, AKF and AFM diagrams).	09
IV	Metamorphic reactions; geothermobarometry; mass and energy change during fluid-rock interactions; Metasomatism, Granitisation, charnockite problem, formation of skarns, progressive and retrogressive metamorphism of pelitic, calcareous and basic rocks; P-T-t path and tectonic setting.	11
V	Ocean floor metamorphism, Cataclastic metamorphism, Paired metamorphic belts., Petrology of important metamorphic rocks – Khondalites, Charnockites, Leptynite, quartzite, slate, marble, migmatites, schist and gneiss.	10
Total		48

Reference Books:

- R1. Bhaskar Rao, B. 1986. Metamorphic Petrology. Oxford & IBH.
- R2. Philpotts, A.R. 1994 Principles of Igneous and Metamorphic Petrology, Prentice Hall.
- R3. Winter, J.D. 2001, An introduction to Igneous and Metamorphic Petrology, Prentice Hall.
- R4. Wood, B.J. and Fraser, D.G. 1976: Elementary Thermodynamics for Geologists, Oxford University Press, London.
- R5. Yardlley, B.W.D. 1989, An introduction to Metamorphic Petrology, Longman Scientific & Technical, New York

Course Outcome	At the end of the course, the students will be able to: <ol style="list-style-type: none"> i) Explore different types of metamorphic rocks and their process of formations. ii) Draw various diagrams like ACF, AKF etc for metamorphic rocks.
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Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL204	Oceanography, Atmospheric Science & Disaster Management	4	40	60

Objectives	The basic objective of this course is to introduce students the ideas of ocean floor and its significance related to several geographic region and climatic condition
Pre-Requisites	Knowledge of world oceans
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with focus on model presentation

Detailed Syllabus

Unit	Topics	Hours
I	Relief and Morphology of ocean floor, Marine sediments and their classification, Sea floor mineral resources, Physical and chemical properties of sea water and their spatial variations. Residence times of elements in sea water.	10
II	Fundamental principles of climatology. Earth's radiation balance; latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity, cloud formation and precipitation, water balance, Air masses.	10
III	The global wind system, monsoon, Jet streams, tropical cyclones, and ENSO. Classification of climates – Koppen's and Thornthwaite's scheme of classification. Climate change.	10
IV	Ocean currents; Formation of subtropical gyres; western boundary currents; equatorial current systems, Ekman's theory; upwelling and sinking, Geostrophic motion; Characteristics of the global conveyor belt circulation and its causes.; El Niño, Monsoonal winds and currents over the North Indian Ocean, waves and tides.	10
V	Climate change, global warming, Concept of disaster management; Management of Earthquake, Cyclone, Tsunami, Flood and Landslide hazards; Hazards related to mining.	08
Total		48

Reference Books:

- R1. Alan P. Trujillo and Harold V. Thurman: Essentials of Oceanography (tenth edition).
- R2. P. R. Pinet (1992): Oceanography: An introduction to the Planet Oceanus, West Pub,Co
- R3. J.Weisberg & H. Parish (1974). Introductory Oceanography. McGraw Hill
- R4.. C. Donald Ahrens: Meteorology Today: An introduction to weather, climate and environment.
- R5. Lal,D.S.,- Climatology, Chaitanya Publication, Allahabad.1986
- R6. Valdiya, K.S. (1987) Environmental Geology – Indian Context. Tata McGraw Hill
- R7. Bryant, E. (1985) Natural Hazards, Cambridge University Press
- R8. Patwardhan, A.M. (1999) The Dynamic Earth System. Prentice Hall
- R9. Subramaniam, V. (2001) Textbook in Environmental Science, Narosa International
- R10. Bell, F.G. (1999) Geological Hazards, Routledge, London
- R11. Smith, K. (1992) Environmental Hazards. Routledge, London

Course Outcome	At the end of the course, the students will be able to: i) Explore different ocean and atmospheric activities ii) Explore the causes and management of disasters
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Sub. Code	Subject Name	Marks	Total	Credit
GL205	GEOLOGY LAB II	35	70	6
	(a) Practical related to Papers GL 201, GL 202			
	(b) Practical related to Papers GL 203, GL 204	35		
	Seminar	30	30	2

Detailed Syllabus

Unit	Topics	Hours
I	Megascopeic and microscopic petrography of igneous rocks, calculation of norm and Niggli values. Megascopeic and microscopic petrography of metamorphic rocks. ACF, AKF and AFM diagrams.	54
II	Megascopeic 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. Determination of resultant palaeocurrent vector and drawing of rose diagram.	54
II	Field Report, Laboratory records and viva voce.	
Total		108

SEMESTER III

Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL301	Paleontology and Quaternary Geology	4	40	60

Objectives	The basic objectives of this units is to know about the characteristic properties, origin and classification of fossils.
Pre-Requisites	Knowledge of fossilization and age of strata
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with focus on hands on practices.

Detailed Syllabus

Unit	Topics	Hours
I	Fossilization Processes (Taphonomy), Modes of preservation. Study of morphology, classification, evolution and extinction of Trilobites, Brachiopods. Lamellibranchs, Gastropods, Cephalopods and Graptolite.	10
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.	10
III	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.	10
IV	Study of morphology and ecology of foraminifers. Morphology and importance of Ostracods, Coccolithophores and Diatoms and conodonts, Palynology.	08
V	Global sea level rise – past and future, Pleistocene glaciations – Causes and effects, Climate changes in Quaternary, Quaternary deposits and landforms of India. Quaternary dating methods; Radiocarbon, Uranium Series, Argon isotope; OSL dating.	10
Total		48

Text Books:

- T1. Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill
- T2. R. C. Moore, C. G. Iallicker and A. G. Fischer (2004) Invertebrate fossils, CBS Pub. & Dist., New Delhi
- T3. Stowe, K.: Exploring Ocean Science: John Wiley, New York

Reference Books:

- R1. B.U. Hag and A. Boersma (1978). Introduction to marine micropaleontology. Elsevier, Netherlands, 376p.
- R2. M.D. Brasier (1980). Microfossils. George Allen & Unwin, London, 193p
- R3. Wadia et al: Quaternary environments and geochronology of India. Geol. Soc. India, Bangalore.
- R4. Vaidyanathan, R. (ed): Quaternary Deltas of India: Geol. Soc. India, Bangalore.
- R5. S. K. Shah (2013) Elements of Paleontology, Geological Society of India, Bangalore

Course Outcome	At the end of the course, the students will be able to: <ol style="list-style-type: none"> i) find out the age of various strata ii) interpret the paleoenvironment.
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Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL 302	Stratigraphy	4	40	60

Objectives	The main objective of studying stratigraphy is to know the logical deposition of strata according to geological time.
Pre-Requisites	Knowledge of deposition, bedding, strata
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive.

Detailed Syllabus

Unit	Topics	Hours
I	Principles of Stratigraphy, Stratigraphic correlation. Standard stratigraphic time scale and their Indian equivalence, Code of stratigraphic nomenclature, Concepts of Sequence-, magneto-, seismic- and chemo-stratigraphy.	10
II	Physiographic divisions of India, General character, stratigraphy, structure, lithology and economic resources of Dharwar, Singhbhum, Eastern Ghats, Aravalli. Detailed study of type areas of Cuddapah and Vindhyan Supergroups and other important groups (Delhi, Chhatisgarh and Kurnool).	11
III	Distribution and detailed study of the type areas of Palaeozoic (Spiti and Kashmir), Mesozoic (Triassic of Spiti, Jurassic of Kutch and Cretaceous of Trichinopoly)	10
IV	Concept of palaeogeographic reconstruction. Paleogeography of India during Permo-carboniferous period, Triassic, Jurassic and Cretaceous Periods.	07
V	General character, stratigraphy, structure, lithology, economic resources and fossil contents of Gondwana Supergroup; Paleogene of Assam, Siwalik Group, Deccantraps, Palaeoclimatic reconstruction., Structure and Stratigraphy of Odisha.	10
Total		48

Text Books:

- T1. M.S. Krishnan 1982. Geology of India and Burma. CBS Publ. & Distributors, New Delhi.
T2. C.O. Dunbar & J. Rodgers 1957 Principles of stratigraphy. John Wiley and Sons, New York.
T3. Ravindra Kumar 1978. Historical Geology and Stratigraphy of India.

Reference Books:

- R1. Naqvi, S.M. and Rogers, J.J.W. (1987): Precambrian Geology of India, Oxford University Press.
R2. Pascoe, E.H. (1968): A Manual of the Geology of India and Burma (Vols.I-IV), Govt. of India Press, Delhi

Course Outcome	At the end of the course, the students will be able to: i) find out the age, ii) lithological constitution and iii) economic importance of various strata.
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Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL303	Economic Geology	4	40	60

Objectives	The main objective of studying Economic Geology is to know about the characteristic properties, origin and distribution of various ore and minerals of India.
Pre-Requisites	Basic knowledge of ore, mineral, mining, prospecting, exploration
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with special focus on Indian minerals.

Detailed Syllabus

Unit	Topics	Hours
I	Ore and gangue minerals, tenor, grade and loads, Processes of formation of Ore deposits: Controls of ore localization, Metallogenic epoch and provinces of India. Mineralogy, mode of occurrence, genesis, uses and Indian distribution of Iron, Manganese, Chromium and Copper ores.	09
II	Mineralogy, mode of occurrence, genesis, uses and Indian distribution of Lead and Zinc, Gold, and Aluminium ores. UNFC classification of ore reserves. Sampling, assaying, ore evaluation and reserve estimation.	09
III	Methods of prospecting, regional exploration and detailed exploration; geological, geochemical and geobotanical methods, geophysical methods (gravity, magnetic, electrical and seismic methods),	09
IV	Drilling, Mining, Ore beneficiation: Comminution, Crushing, Grinding, Different techniques of beneficiation: gravity separation, jigging, dense media separation; Tabling, froth floatation, magnetic and electrostatic separation. Ore beneficiation practices adopted in Fe, Mn, Al, Cr ore deposits.	10
V	National mineral policy, strategic, critical and essential minerals, Sustainable mineral development. Industrial minerals: Minerals/Rocks used in cement, refractories, ceramics and fertilizer industries. Mode of occurrence, genesis and Indian distribution of Mica, Asbestos, Graphite, Gypsum, limestone and barites. Gem stones of Odisha.	11
Total		48

Text Books:

T1. G.B. Mohapatra (2010) Text book of Geology; CBS Pub. & Dist., New Delhi

Reference Books:

- R1. Chandra, D., Singh, R.M. Singh, M.P., 2000: Textbook of Coal (Indian context). Tara Book Agency, Varanasi.
- R2. Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
- R3. James R. Craig and David J. Vaughan (1994): Ore Microscopy and Petrography.
- R4. Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits, Springer-Verlag.
- R5. Levorson, A.I. Geology of Petroleum.
- R6. Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
- R7. Selley, R.C., 1998: Elements of Petroleum Geology. Academic press.
- R8. Singh, M.P. (Ed.) 1998: Coal and organic Petrology. Hindustan Publishing Corporation, New Delhi.

Course Outcome	At the end of the course, the students will be able to: <ol style="list-style-type: none"> i) Find out the properties and uses of minerals, ii) Know the distribution of economic minerals iii) Explore the economic importance of various minerals. iv) Know conservation and management of economic minerals
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Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL304	General Geology and Mineral Resources of Odisha	4	40	60

(CBCS for other departmental students)

Objectives	The main objective of studying General Geology and Mineral Resources of Odisha is to get elementary idea about the General Geology of the earth, various Geological activities and too aware about the mineral resources available in Odisha.
Pre-Requisites	Knowledge of Geologic agents, ore, rock, mineral, mining
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with special focus on Orissa mineral resources.

Detailed Syllabus

Unit	Topics	Hours
I	Origin of the earth, internal structure of the earth, volcano, earthquake, concept of plate tectonics.	10
II	Principles of geomorphology, Different geomorphic agents, Landforms developed by Wind, River, Glacier, Ground water, Sea	10
III	Vertical distribution of Ground water, porosity, permeability, specific yield and specific retention. Types of water bearing formations- Aquifers, Aquicludes, Aquitards and Aquifuge. Classification of aquifers.	08
IV	Introduction to mineralogy, Study of different mineral groups, Formation and classification of rocks (Igneous, Sedimentary and Metamorphic rocks) and petrography of different rocks	10
V	Introduction to economic geology, Economic mineral resources of Odisha- Iron, Manganese, Chromite, Bauxite, Coal, Graphite and Beach placer deposit	10
Total		48

Text Books:

- T1. G.B. Mohapatra (2010) Text book of Geology; CBS Pub. & Dist., New Delhi
T2. G.B. Mohapatra (2010) Text book of Physical Geology; CBS Pub.
T3. V. Radhakrishnan (1987) General Geology, V.V.P. Publishers, Tuticorin

Reference Books:

- R1. Holmes, A. 1992: Holmes Principles of Physical Geology Edited by P. McL. D. Duff. Chapman and Hall, London.
R2. Mineral Resources of Odisha (2006), SGAT, Bhubaneswar
R3. Sharma, H.S. 1990: Indian Geomorphology. Concept Publishing Co. New Delhi.
R4. Siddhardha, K. 2016: The Earth's Dynamic Surface- A book of Geomorphology, Kitab Mahal

Course Outcome	At the end of the course, the students will be able to: <ul style="list-style-type: none"> i) Aware about the various geological activities undergoing in the earth system. ii) Describe various types of rocks/minerals etc. iii) Describe distribution of economic minerals of Odisha
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Sub. Code	Subject Name	Marks	Total	Credit
GL305	GEOLOGY LAB III	35	70	6
	(a) Practical related to Papers GL 301, GL 302			
	(b) Practical related to Papers GL 303	35		
	Seminar	30	30	2

(PRACTICAL RELATED TO PAPERS GL 301, GL 302 & GL 303)

Detailed Syllabus

Unit	Topics	Hours
I	Identification of animal and plant fossils as stated in theory. Graphic representation of their stratigraphic intervals. Arrangement of fossils in chronological order. Drawing and labeling of fossils. Stratigraphic assemblages – Identification and interpretation.	27
II	Megascope identification of metallic and nonmetallic minerals, Microscopic identification of ore minerals and their textures.	27
III	Calculation of assay value and reserve.	54
	Laboratory records and viva voce.	
	Total	108

SEMESTER IV

Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL401	Groundwater & Engineering Geology	4	40	60

Objectives	The main objective of studying Groundwater & Engineering Geology is to know the characteristic properties, origin and types of groundwater and to know the requirement of geology for the construction of various engineering structures such as bridge, tunnel etc.
Pre-Requisites	Knowledge of Geologic deformations, engineering properties of rocks.
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with special focus on Indian context.

Detailed Syllabus

Unit	Topics	Hours
I	Global distribution of water, Hydrologic cycle, Vertical distribution of Groundwater, Hydrologic properties of water bearing materials- porosity, permeability, specific yield and specific retention, Hydraulic conductivity and transmissivity.	08
II	Types of water bearing formations- Aquifers, Aquicludes, Aquitards and Aquifuge. Classification of aquifers. Groundwater movement storage coefficient, Cone of depression. Darcy's Law in isotropic and anisotropic media, Design and construction of tube well.	08
III	Groundwater exploration- Geological, Geophysical and remote sensing methods. Well drilling techniques. Quality of groundwater and quality criteria for different uses. Groundwater provinces of Odisha and India, Saline water intrusion, Wastewater management, Organic and inorganic contamination of groundwater and their remedial measures, Artificial Recharge of Groundwater.	08
IV	Engineering properties of rocks and soil; Geological investigations in construction of Tunnels, Bridges, Highways and Coastal protection structures; Earthquake resistant structure.	12
V	Building materials (road metals, building stones, concrete aggregate). Landslides and stability of slopes., Geotechnical considerations in dams and reservoirs and their environmental impact. Case studies of major dam projects: Hirakud and Bhakra.	12
Total		48

Reference Books:

- R1. Beavis, F.C. 1985. Engineering geology
- R2. Bell, F.G. 1983. Fundamentals of engineering geology.
- R3. Davies, S.N. and De-West, R.J.N. (1966): Hydrogeology, John Wiley & Sons, New York.
- R4. Davis, S.N. & De Wiest, R.J.N. 1966. Hydrogeology. John Wiley & Sons, New York.
- R5. Ground Water and Wells (1977): UOP, Johnson, Div. St. Paul. Min. USA
- R6. Raghunath, H.M. 1983. Groundwater. Willey Eastern, Calcutta.
- R7. Todd, D.K. 1988. Groundwater Hydrology. John Willey and Sons.

Course Outcome	At the end of the course, the students will be able to: <ol style="list-style-type: none"> i) Enable the students to use groundwater properly and will have the knowledge to install various types of wells. ii) Know the requirement of geology for the construction of various engineering structures such as bridge, tunnel etc.
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Sub. Code	Subject Name	Credit	Int. Mark	End term Mark
GL402	Remote Sensing, GIS and Geostatistics	4	40	60

Objectives	The main objective of studying this course is to understand the aerial photography and its types with uses, remote sensing techniques and its application at several aspects of geological study and apply the knowledge of statistics in analyzing geological sample records
Pre-Requisites	Knowledge of photograph analysis and computer operation.
Teaching Scheme	Regular classroom lectures with use of ICT tools as and when required, sessions are planned to be interactive with special focus on Indian satellites

Detailed Syllabus

Unit	Topics	Hours
I	Air-borne remote sensing: Concepts and principles of aerial photography, Aerial photographs - Types, Scale, Stereoscopy, Photo mosaics, Photo elements and photo interpretation.	10
II	Principles of Remote sensing, Types of platforms and sensors; Sensor resolution Remote sensing satellites Thermal radiation, Black body radiation, Interaction of EMR with terrain elements, Fundamentals of Microwave remote sensing, False colour composite, Interpretation of satellite imagery, Applications of remote sensing in landform and land use mapping, Structural mapping, Mineral and Groundwater exploration.	10
III	Concept and Objectives of Geographical Information Systems (GIS), conceptual models of spatial information- raster and vector data models, Digital Image processing, Digital Elevation Model, Global Positioning System.	08
IV	Probability – concept, laws and application. Sampling methods; Frequency distribution and frequency tables. Graphical representation of frequency data - histogram, frequency curve and cumulative frequency curve. Normal frequency distribution.	10
V	Degrees of freedom and level of significance. Correlation coefficient. The t-test – equality of sample means and significance of correlation coefficient. Chi-square test – goodness of fit. F-test and analysis variance. Least square method and regression analysis. Application of computer in solving statistical problems in geology.	10
Total		48

Reference Books:

- R1. Bhatta B, 2011: Remote Sensing and GIS 2nd Edition, Oxford University Press
- R2. Davis, J.C. (1984) Statistics and data analysis in geology. John Wiley, New York
- R3. Gupta, R.P. (1991) Remote Sensing Geology. Springer-Verlag. 356pp.
- R4. Lilles T.M., Kiefer, R.W. and Chipman, J. 2008: Remote Sensing and Image Interpretation. 6th Edition, John Wiley and Sons
- R5. Miller, V.C. & Miller, C.F. 1961. Photogeology. McGraw Hill, New York.
- R6. Pandey, S.N. 1987. Principles and applications of photogeology. Wiley Eastern, New Delhi.
- R7. Ray, R.G. 1969 Aerial photographs in geologic interpretation. USGS Professional Paper 373.

Course Outcome	At the end of the course, the students will be able to: <ol style="list-style-type: none"> i) Analyze aerial photograph ii) Apply remote sensing techniques in geological study iii) Geological field data analysis using statistics tools
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Sub. Code	Subject Name	Marks	Total	Credit
GL403	Dissertation	200	200	8

- Guide/supervisor will be allotted to each student during the month of July/August.
- Each student must undergo internship/training/field work for a period of minimum 30 days in any Industry/Mines/Research Organisation etc. at own cost in the 4th Semester.
- With the help of guide/supervisor, the student has to prepare the dissertation thesis.
- The thesis will be evaluated in a poster/PowerPoint presentation seminar by external as well as internal members.
- The students will be encouraged to write at least one research paper out of the dissertation work.

Guideline for printing of Dissertation thesis:

1	Paper size	A4
2	Orientation	Portrait
3	Font	Calibri
4	Font size (Heading)	14
5	Font size (Body)	12
6	Line Spacing	1.5
7	Border Line	No border line
8	Margin	Left: 2.5cm, Right: 2cm, Top: 2cm, Bottom: 2cm
9	Column	One
10	Water Mark	No water mark
11	Page Number	Bottom, Middle, Calibri, 12, simple
12	References	As per Journal of Geological Society of India
13	Certificate Format	Collect Sample format from Office
14	Binding	Soft binding

Sub. Code	Subject Name	Marks	Total	Credit
GL404	Practical related to Papers GL 401 & GL 402	70	100	6
	Seminar Presentation	30		2

(PRACTICAL RELATED TO PAPERS GL 401 & GL 402)

Detailed Syllabus

Unit	Topics	Hours
I	<p>Practical relating to papers GL401 Analysis of Seismic Refraction, and Resistivity survey data, analysis and interpretation of bore hole logs. Water table contour maps, Determination of pH, conductance, total hardness of water samples. Soil study, Geological problems in dams, Tunnels and Bridges. Engineering properties of rocks.</p> <p>Practical relating to papers GL402 Marking of principal points. Determination of scale. Tracing of details from aerial photos and imageries. Stereoscopic test, 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.</p>	54