

MANGALORE UNIVERSITY
DEPT. OF MARINE GEOLOGY
M. Sc. MARINE GEOLOGY SYLLABUS (CHOICE BASED CREDIT SYSTEM)
STRUCTURE OF THE COURSE

Semester	Paper Theory / Lab	Instruction hrs/Week Lectures / Practicals	Duration of Exams (hrs)	Marks			Credits
				IA	Exam	Total	
First Semester :							
MG 401	Mineralogy and Geochemistry	4	3	30	70	100	4
MG 402	Petrology	4	3	30	70	100	4
MG 403	Geodynamics and Geophysics	4	3	30	70	100	4
MG 404	Economic Geology and Mining Geology	4	3	30	70	100	4
MG 405	Mineralogy and Geochemistry (Lab)	8	4	30	70	100	4
MG 406	Petrology (Lab)	8	4	30	70	100	4
---	Seminar and Field Work	2	-	50	-	50	2
	Semester Total					650	26
Second Semester :							
MG 451	Structural Geology and Geomorphology	4	3	30	70	100	4
MG 452	Stratigraphy and Paleontology	4	3	30	70	100	4
MG 453	Hydrogeology and Environmental Geology	4	3	30	70	100	4
MG 454	Atmospheric Science and Photogrammetry	4	3	30	70	100	4
MG 455	Structural Geology and Palaeontology (Lab)	8	4	30	70	100	4
MG 456	Hydrogeology and Geostatistics & CA (Lab)	8	4	30	70	100	4
---	Seminar and Field Work	2	-	50	-	50	2
	Semester Total					650	26
Third Semester :							
MG 501	Geo-sciences (Elective)	4	3	30	70	100	4
MG 502	Remote Sensing and GIS	4	3	30	70	100	4
MG 503	Oceanography - I	4	3	30	70	100	4
MG 504	Oceanography - II	4	3	30	70	100	4
MG 505	Remote Sensing and GIS (Lab)	8	4	30	70	100	4

MG 506	Physical Oceanography and Surveying (Lab)	8	4	30	70	100	4
---	Seminar and Field Work	2	-	50	-	50	2
Semester Total						650	26
Fourth Semester :							
MG 551	Dissertation					300	12
	Viva - Voce					100	4
	Field Work					100	4
	Field Report					50	2
Semester Total						550	22
Grand Total						2500	100



FIRST SEMESTER

MG 401: MINEROLOGY AND GEOCHEMISTRY

Mineralogy

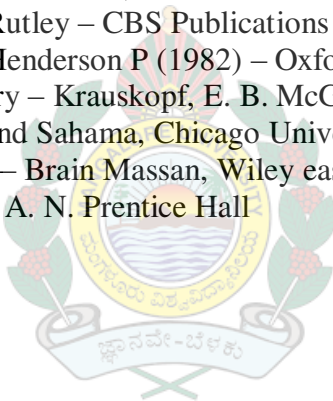
Unit 1	Introduction and Principles of Mineralogy: Definition and importance of minerals for sustainable development. Properties of minerals: chemical, physical, electrical, magnetic and thermal.	8 hrs
Unit 2	Symmetrical elements and crystal systems.	8 hrs
Unit 3	Principles of optical and x-ray mineralogy. Classification of Minerals. Ore and ore forming minerals	8 hrs
Unit 4	Descriptive Mineralogy: Silicates-Structural classifications. Description of major rock forming minerals of the following groups; Olivine, Pyroxene, Amphibole, Garnet, Mica, Feldspar, Quartz, Aluminosilicate, Zeolites, Clay minerals.	8 hrs

Geochemistry

Unit 5	Introduction to geochemistry and cosmochemistry: Origin of elements and their cosmic abundance in the universe. Structure and atomic properties of elements, Periodic Table. Chemical and geochemical classification of elements. Meteorites and their applications. Composition of earth interior	8 hrs
Unit 6	Distribution of elements in igneous, sedimentary and metamorphic processes with an importance of magmatic and weathering and sedimentary processes. Factors regulating the composition of aerosols, soil and sediments.	8 hrs
Unit 7	Introduction to biogeochemistry. Principles of geochemical cycle including human activity in altering the system. Bio-geochemical cycling of carbon, nitrogen and phosphorous.	8 hrs
Unit 8	Isotope geochemistry and principles of geochronology. Radioactive and stable isotopes, and fission products; and their classifications and applications in different fields of the earth science.	8 hrs

Books for Reference:

1. Rock Forming Minerals – Deer, Howie and Zussman: Longman Publishers
2. Text Book of Mineralogy – J. D. Dana, E. S. Asia Publ House
3. Elements of X-ray Crystallography – Azaraoff
4. Elements of Optical Mineralogy – Winchell, Wiley eastern Limited
5. Mineralogy – Berry I. G. and Masson, B. Freeman and Co.
6. Elements of Mineralogy – Rutley – CBS Publications
7. Inorganic Geochemistry – Henderson P (1982) – Oxford – Pergamon
8. Introduction to Geochemistry – Krauskopf, E. B. McGraw Hill
9. Geochemistry – Rankama and Sahama, Chicago University Press
10. Principles of Geochemistry – Brain Massan, Wiley eastern limited
11. Geochemistry – Brownlow, A. N. Prentice Hall
12. Rock Forming Minerals – Deer, Howie and Zussman: Longman Publishers
13. Text Book of Mineralogy – J. D. Dana, E. S. Asia Publ House
14. Elements of X-ray Crystallography – Azaraoff
15. Elements of Optical Mineralogy – Winchell, Wiley eastern Limited
16. Mineralogy – Berry I. G. and Masson, B. Freeman and Co.
17. Elements of Mineralogy – Rutley – CBS Publications
18. Inorganic Geochemistry – Henderson P (1982) – Oxford – Pergamon
19. Introduction to Geochemistry – Krauskopf, E. B. McGraw Hill
20. Geochemistry – Rankama and Sahama, Chicago University Press
21. Principles of Geochemistry – Brain Massan, Wiley eastern limited
22. Geochemistry – Brownlow, A. N. Prentice Hall



MG 402: PETROLOGY

Igneous Petrology

- Unit 1** Magma and its properties: Magma, its generation in the crust and mantle, physical and chemical properties, partial melting, fractional crystallization, differentiation and assimilation. 8 hrs
- Unit 2** Classification of igneous rocks. Forms, structure and textures of igneous rocks. 8 hrs
- Unit 3** Distribution and description of important igneous rocks: Granites, basalt, syenites, peridotite, carbonatite, dolerite, lamprophyres, kimberlite and their associated mineral deposits with special reference to India. 8 hrs

Sedimentary Petrology

- Unit 4** An outline of the sources and formation of sediments. Classification of sediments and sedimentary rocks. 8 hrs
- Unit 5** Diagenesis of sediments. Textures and structures of sedimentary rocks. 8 hrs
- Unit 6** Descriptive Petrology: Rudites – Breccias and conglomerates; Arenites- sandstones, greywacke; Argillites–shales, Carbonates - limestones and dolomites; 8 hrs

Metamorphic Petrology

- Unit 7** Metamorphism: Introduction, definition and types, ocean-floor metamorphism and paired metamorphic belts, diagenesis vs. metamorphism. Factors in metamorphism: temperature, pressure and fluids. 8 hrs
- Unit 8** Textures and structures of metamorphic rocks: Grades of metamorphism. Gneisses, granulites, quartzites, schists, slates and marbles. 8 hrs

Books for Reference:

1. Sedimentary petrology F. J. Pettijohn.
2. Stratigraphy and Sedimentation, W.H. Freeman – Krumbein and Sloss.
3. Petrology of sedimentary rocks - Greensmith
4. Depositional Sedimentary environments, Springer–H.E. Reineck and I.B. Singh
5. Petrology – Loren A Raymond, Wm C. Brown Publishers, Chicago
6. Principles of Petrology – G. W. Tyrell, Asia Pub. House, New Delhi
7. Petrology – Ehlers and Blatt, CBS Publ
8. Igneous and Metamorphic Petrology – Turner and Verhoogen, CBS Publications
9. Igneous and Metamorphic Petrology – Best, CBS Publications
10. Students Petrology – Allen and Nockolds
11. A Practical Approach to Sedimentology - CBS Pub. – R.C. Lindholm.
12. Sedimentary Rocks, CBS Pub. – F. J.

MG 403: GEODYNAMICS & GEOPHYSICS

Geodynamics

- Unit 1** Introduction to Geodynamics. Earth's Internal Structure: An outline of seismic waves. Earthquakes- magnitude, intensity and distribution. Composition of the crust, mantle and core. Thermal history of Earth. Mantle convection and related mechanism. Seismic zonation of India. Paleomagnetism: Polar wandering curve and magnetic reversals. Paleomagnetism Magnetostratigraphy and Sea Floor Spreading. 8 hrs
- Unit 2** Continental Drift: Concept and evidences. The concept of the Super continent. Gondwanaland and its fragments. Vertical Tectonics: Introduction to Vertical tectonics. Concept of Isostasy. 8 hrs
- Unit 3** Plate Tectonics: Concept of Plate Tectonics. Major and minor plates. Mechanism of plate motion, Mantle convection. Rift Valleys. 8 hrs

Geophysics

- Unit 4** Magnetic methods: Principles of Magnetism. General outlines of magnetometers. Magnetic techniques: Nettleton's depth to the pole methods. Determination of depth to the centre of Single Pole, Sphere, Horizontal Cylinder and Faulted Slab using magnetics. Construction of Residual Anomaly Maps using Griffin's Techniques. Cook's computations of magnetic anomalies over inclined dyke, dipping bodies etc. Peter's Slope method to determine the depth to the source of the causative body of the anomaly. 8 hrs
- Unit 5** Marine Geophysical Surveys: Survey plans, GPS, Echosounders and their uses, Marine Seismics, Sources of energy, detectors, Streamers and their uses, Recoding devices. Case Studies for Geophysical Prospecting: Prospecting for oil, placer and onshore mineral deposits. Case studies: Studies of the Cambay and Anklesvar basins. Magnetism on faulted structures of Sanchor area of Rajasthan, Magnetism on Manganese ore bodies of Kursk and Tirodi. Marine Magnetism to detect placer deposits of magnetite and ilmenite of the West Coast of India. 8 hrs
- Unit 6** Gravity methods: Principles of gravity. Gravity anomalies and corrections. Gravity anomaly maps and their interpretations. Interpretation of Gravity Anomalies due to Bodies of simple Geometric forms-sphere, cylinder, horizontal slab. Empirical determination of maximum effect gravity Δg_{max} on buried sphere, horizontal cylinder etc. **Case studies:** Bouguere anomaly map of Nahorkatiya, Kadi-Gujarath, Cambay Basin, Anklesvar Oil Field 8 hrs

Unit 7 Seismic methods: Principles of Seismic and Elastic properties. 8 hrs
Geophones, Hydrophones and travel time curves. Reflection and Refraction methods. Fan shooting, Arc shooting and Profile shooting.

Unit 8 Well Logging Techniques: Electrical Logging, Radioactive 8 hrs
Logging, Sonic Logging and Miscellaneous Logging

Reference books:

1. Brain F. Windley (1977) The Evolving Continents John Wiley & Sons. 385p.
2. Burk, C.A. & Drake, C.L. The Geology of Continental Margins- Springer Verlag, NY
3. Condie, K.C. Plate tectonics and Crustal Evolution, Pergamon Press, 288p.
4. Christopherson, R. W., (1995) Elemental Geosystems A foundation in Physical Geography. Printice Hall Inc., 580p.
5. Vine, F. J., and Matthews, P. M. (1963) Magnetic anomalies over ocean ridges. Nature, 199, 947-949.
6. Bott, M.H.P., (1971) The Interior of the Earth. Arnold, London, 316pp.
7. Khan, M. A., (1975) The Afro-Arabian Rift System. Sci. Prog. 62, 207-236.
8. McElhinny, (1973) Palaeomagnetism and Plate Tectonics. Cambridge Univ. Press, 358pp.
9. Ramachandra Rao, M. B (1975). Outlines of Geophysical Prospecting: A manual for Geologist E.B.D. Educational Pvt. Ltd. Dehra Dun. 403pp.
10. Parasnis, D. S. (1979) Principles of applied Geophysics. Chapman and Hall, - 275 pages
11. Dobrin, M.B. 1976 Introduction to Geophysical Prospecting. New York McGraw-Hill, 630p.

MG 404: Economic Geology and Mining Geology

Economic Geology

Unit 1	Hydrocarbons: Classification, origin, migration and accumulation of petroleum; properties of source and reservoir rocks; structural, stratigraphic and combination traps. Methods of petroleum exploration. Petroliferous basins.	8 hrs
Unit 2	Coal: Definition, bands, origin of coal, rank and grading of coal, peat, lignite, bituminous and anthracite. Coal petrology. Gondwana and Tertiary coal resources of India. National mineral policy.	8 hrs
Unit 3	Origin of ore deposits. Classification of mineral deposits – renewable and non-renewable deposits, metallogenic provinces and epochs.	8 hrs
Unit 4	Metallic deposits: origin, occurrence, and geology of iron, manganese, copper, gold, aluminium and chromite deposits in India with particular reference to Karnataka.	8 hrs
Unit 5	Non-metallic deposits: origin, occurrence, of minerals used in refractory, abrasives, chemicals, fertilizer, cement and electrical industries, building materials.	8 hrs
Unit 6	Precious stones: diamonds including gem and industrial varieties. Semiprecious stones: garnet, corundum, beryl etc.	8 hrs

Mining Geology

Unit 7	Mining / quarrying techniques: Introduction, definition, aim, and scope of mining of natural resources. Methods of mining: alluvial mining, open cast mining, quarrying, loading, glory hole, kaoline mining.	8 hrs
Unit 8	Underground mining methods- stopping and caving, coal and metallic minerals mining. Ventilation and mine supports. Indicators of ore deposits.	8 hrs

Books for Reference:

1. The Sea, vol.5, p.491, 527; vol. 7, p.589, 639,875, 981
2. Seibold and Berger: The seafloor
3. Renard: Geology, Resources and Society
4. R.W. Tank: Focus on Environmental Geology (p.256)
5. R.A. Horne: Marine Chemistry (p.444)
6. M. Grant Gross (1995): Principles of Oceanography (p.131).
7. G.S. (1989): Marine minerals in the Ocean. JGSI, 34:182-192
8. D.S. Cronan: Underwater minerals
9. Paul R. Pinet (1992): Oceanography (P.149)
10. An Open University Course Team (1989): Seawater: Its composition, properties and behaviour (pp.33)
11. Bhandari et al. (ed.): Petroliferous basins of India.
12. Bjorlykke K. (1989): Sedimentology and Petroleum Geology.
13. Abdulin: Petroleum and Natural Gas Production.
14. Sidorov: Petroleum and Natural Gas wells (p.35).
15. G.S. Roonwal: Petroleum Resources-Indian Ocean.
16. Economic Mineral Deposits – Bateman
17. India's Mineral Wealth - Oxford Univ. Press - Brown and Dey (1975)
18. Indian Mineral Resources – Kirshnaswamy
19. Earth Resources – Skinner
20. Industrial Minerals & Rocks of India - Allied Publishers - Deb, S.(1987)
21. Ore Deposits - W.H. Freeman - Park C.F.(1975)
22. Oceanic Mineral Resources - John L Mero Bamery, K.D
23. Mineral Deposits of the Deep Ocean Floor - Ulmanns & Skinner B .J.
24. Extraction from Sea Water - Technischen chemie – Encyclopädie
25. Encyclopedia of Chemical Technology - John Wiley & Sons - Othmer, Kirk
26. Mineral Economics - Call.No.553 - Sinha & Sharma.
27. Courses in Mining Geology – R.N.P. Arogyaswamy, Oxford & IBH Publishing Co.

MG 405: MINERALOGY & GEOCHEMISTRY (Lab)

Mineralogy (Lab)

1. Megascopic study of important rock forming minerals.
2. Crystallography: Crystal systems and angular relationships.
3. Calculation of mineral formula from chemical data of olivine, garnet, pyroxene and amphibole.
4. Identification of mineral samples collected by students during field work.

Geochemistry (Lab)

1. Introduction to principals of geochemical analyses.
2. Determinations of moisture content, porosity, and density of sediment samples.
3. Determination of chlorosity and estimation of salinity of fresh water and seawater; and practical importance of salinity measurements in estuarine and coastal oceanography.
4. Measurements of hardness, calcium and magnesium carbonates and their implications for understanding water chemistry.
5. Estimation of dissolved oxygen in natural waters. Importance of oxygen saturation and consumption.
6. Determination of carbon dioxide, acidity/alkalinity of natural water samples. Estimation of partial pressure of carbon dioxide in water samples.
7. Standards of determining the water quality: WHO, EPA and Indian standards.
8. Geochemical analysis of samples collected by students.

MG 406: PETROLOGY (Lab)

1. Identification of igneous, sedimentary and metamorphic rocks (hand specimen).
2. Study of mega structures, textures and mineralogy of igneous, sedimentary and metamorphic rocks.
3. Microscopic study of igneous, sedimentary and metamorphic rocks.

SECOND SEMESTER

MG 451: STRUCTURAL GEOLOGY & GEOMORPHOLOGY

Structural Geology

- Unit 1** **Introduction:** structural geology and its importance with other branches of geology. Dip and strike. Primary structures in sedimentary rocks: Stratification, current bedding, graded bedding, ripple marks, mud-cracks, rain prints etc. 8 hrs
- Unit 2** **Force, stress and strain:** Force and acceleration, composition and resolution of forces. Concept of stress and strain; strain analysis using deformation objects. : Parts of a fold. Geometrical classification of folds. Mechanics and causes of folding. Criteria for recognition of folds in the field. 8 hrs
- Unit 3** **Folds and Faults:** Parts of a fold. Geometrical classification of folds. Mechanics and causes of folding. Criteria for recognition of folds in the field. **Faults:** General characteristics, nature of movement along faults. Geometric and genetic classification of faults. Mechanics of faulting. Criteria for recognition of faults in the field. 8 hrs
- Unit 4** **Joints and Unconformities:** Geometry and classification of joints. Field studies, importance of joints in geological, structural/civil engineering studies. Different types of unconformities. Recognition of unconformities. Criteria to differentiate between faults and unconformities. 8 hrs

Geomorphology

- Unit 5** Nature and scope of Geomorphology, Fundamental concepts- Recent trends in Geomorphology. Approaches to geomorphology- static, dynamic, environmental and applied. Earth movements – Landforms - endogenetic and exogenetic, epirogenic and orogenic, climatic and tectonic factors and rejuvenation of landforms. Dynamics of geomorphology; geomorphic processes and resulting landforms. 8 hrs
- Unit 6** Basic principles. Concepts of gradation, types of weathering and soils, mass wasting. Concept of erosion cycles. Geomorphology of fluvial tracts, arid zones, coastal regions, Karst landscapes and glacial regions. 8 hrs
- Unit 7** Applied Geomorphology: Flood management, Integrated coastal zone management. Applications of geomorphology in mineral prospecting, civil engineering, hydrology and environmental studies. Geomorphology of India with special reference to Karnataka. 8 hrs
- Unit 8** Geomorphic mapping based on genesis of landforms; morphometric analysis and modeling terrain evaluation for strategic purposes. Applications of geomorphology to route alignment and site selection (highways and dams). Applications of Remote sensing and GIS in geomorphology. Applications of DEM in Geomorphology. 8 hrs

Books for Reference:

1. The Geology of Continental Margins - Springer Verlag, NY - Burk C. A. & Drake, C. L. (1974)
2. The Evolution Passive Continental Margins - The Royal Society of London (1980) in the Light of Deep Drilling Results. Phil, Trans R. Soc. London, A. 294
3. Earth Dynamics - BLOCK 4, The Open University Press - Open University Series (1982)
4. Earthquake Waves and the Earth's Interior - UNIT4/5 - Open University Series (1982)
5. Earth Structure - BLOCK 2 The Open University press (1982) - Open University Series (1982)
6. The Interior of the Earth - Bott, M.H.P. (1982)
7. Introduction to Geophysics - Toppen Publ.Co., Tokyo - Garland, G.D. (1971)
8. Geodynamics Elsevier - Artyushkov E.V. (1983)
9. Plate Tectonics and Crustal Evolution, Pergamon Press - Condie, K.C. (1989)
10. Physical Geology - Wm and C Brown - Montgomery, C.W. (1990)
11. The Dynamic Earth - John Wiley - Skinner, B.J. and Porter, S.C. (1995)
12. Field Geology – McGraw Hill Book Co. - Lahee, F.H. (1961)
13. Folding and Fracturing of Rocks - McGraw Hill Book Co. - Ramsay, J.G. (1967)
14. Structural Geology – 3rd edition, Prentice Hall - Billings M.P. (1977)
15. Structural Geology of Rocks and Regions - John Wiley & Sons - Davis, G.H. (1984)
16. Structural Geology Principles, Concepts and Problems, 2nd Edition, New Jersey Prentice Hall - Hatcher, Robert D. (1995)
17. Structural Geology – W.H. Freeman, New York - Twiss, Robert J. (1992)
18. Structural Geology – McGraw Hill - Timothy Whetten (1975)
19. Fundamentals of Engineering Geology - Butterworths – Bell F.G. (1983) Principles.
20. Fundamentals of Historical Geology and Stratigraphy of India, Ravindrakumar New Age International Pub.
21. Knighton, D. 1998. Fluvial forms and processes: A new Perspective, Arnold, London, 385p.
22. Morisawa, M. 1985. Rivers, Longman, London 222p.
23. Murthy, K.S. 1998. Watershed management in India, 3rd edition, Wiley Eastern Ltd. New Age International Ltd, New Delhi, 198 p.
24. Pethick, J. 1984. An introduction to Coastal Geomorphology, Edward Arnold, London, 259p.
25. Ritter, D.F., R.C. Kochel and J.R. Miller (2011) *Process Geomorphology*, 5th edition. McGraw Hill, NY. Rental text.
26. Summerfield, M.A. (Editor), 1991. Global Geomorphology: An introduction to the study of landforms, John Wiley and Sons Ltd., New York: 560p.
27. Thornbury, W.D. (1969): Principles of Geomorphology, Wiley Eastern Limited, New Delhi: 594 p.
28. Tinkler, 1985. A short history of Geomorphology, Croom-Helm, London.
29. Rice (1998): Fundamentals of Geomorphology.
30. Kale & Gupta (2001): Introduction to Geomorphology.

MG 452: STRATIGRAPHY AND PALAEONTOLOGY

Stratigraphy

- Unit 1** Introduction: Principles of stratigraphy, new concepts and mass extinction. Concept of measurement of time, geological time scale and global stratigraphic chart. Stratigraphic classification: Litho, bio, chrono, seismic and magneto stratigraphic units and their inter-relationships. 8 hrs
- Unit 2** A brief review of global stratigraphy. Physiographic and tectonic subdivisions of India; Evolution of the Indian subcontinent since the Archaean eon. 8 hrs
- Unit 3** Proterozoic basins of India with emphasis on lithological, geochemical, stratigraphic and geochronological aspects. Geological setting and important stratigraphic features of Phanerozoic formations in India such as Gondwanas, Deccan Traps, Indo-Gangetic Plains and Himalayas. 8 hrs
- Unit 4** Boundary problem and its significance in stratigraphy with emphasis on the Cretaceous- Tertiary boundary. Importance of Cenozoic Era with reference to evolution of climate and life. Quaternary period: Glacial and inter-glacial epochs. Sea-level fluctuations, causes and consequences. 8 hrs

Palaeontology

- Unit 5** Branches of palaeontology. Theories on origin of life. Organic evolution, mass extinctions and their causes. Application of fossils in age determination and correlation. Fossils, fossilisation, conditions required for preservation of fossils. Species concept, trace fossils, index fossils and pseudo-fossils. Modes of preservation of fossils (petrification, mould, cast, compressions, impressions, tracks, trails, burrows, foot prints and resting marks). Rock types in which fossils occur. 8 hrs
- Unit 6** Important invertebrate fossils - Morphology, classification, evolution, age and stratigraphic importance of Porifera, Coelenterata, Brachiopoda, Mollusca, Arthropoda and Echinodermata. Important vertebrate fossils. Siwalik vertebrate fauna. 8 hrs
- Unit 7** Palaeobotany: Evolution of plant life, plant fossils and fossilization. Gondwana and Tertiary flora. An account of Algae, Spores and Pollens. 8 hrs
- Unit 8** Micropalaeontology: Extraction of microfossils from sediments. Types of microfossils. Different microfossil groups (Foraminifera, Ostracoda, Acritarcha, Radiolaria, Diatoms, Nannoplankton and Dinoflagellates). Applications of microfossils in Earth Sciences. Environmental significance of fossils and trace fossils. Application of micropalaeontology in hydrocarbon exploration. 8 hrs

Books for Reference:

1. Stratigraphic Principles and Practice - M .J. Weller
2. American Code of Stratigraphic nomenclature and terminology- H.D. Hedberg Evolution of Vertebrates – E. M. Colbert – CBS Publications
3. Principles of Paleontology – Raup and Stanley – CBS Publications
4. Principles of Invertebrate Paleontology – Shrock and Twenhofel – CBS Publications
5. Elemental Geosystem Printice Hall, Inc.- R.W. Christopherson (1995)
6. The dynamic Earth:An introduction, Skinner & S.C. Porter, John Wiley and Sons - J.
7. Climate Processes and Change Cambridge Univ. Press – E. Bryant (1997)
8. Fossil Invertebrates, Cambridge Univ.- Lehmann, U and Hilimer, G. (1983)
9. Distribution and Ecology of Living Benthonic Foraminifera - Murry, J. (1973)
10. Principles of Micropaleontology, Hafner - Glassner, M.F. (1972)
11. Micropalaeontology, George Allen and Unwin -Brasier M.D. (1980)
12. Micropalaeontology, Graham & Trotman - Bignot, G. (1985)
13. Invertebrate Fossils, Mcgraw Hill - Moore, Lalicker and Fisher (1952)
14. Introduction to Micropalaeontology - Haq, B.U.
15. An introduction to Paleobotany - Arnold, Chester R
16. Palaeontology - Invertebrate 8th Ed, CBS Publ. and Distributors - Woods Henry (1981).
17. Fundamentals of Historical Geology and Srtatigraphy of India, Ravindrakumar New Age International Publication.



MG 453: HYDROGEOLOGY & ENVIRONMENTAL GEOLOGY

Hydrogeology

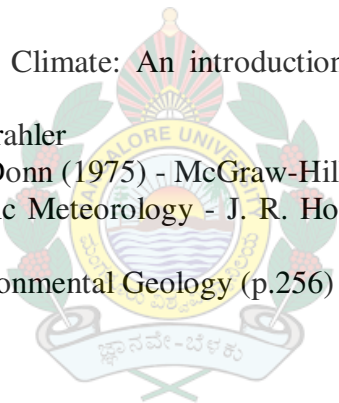
- Unit 1** Ground water: Origin of water, types, importance, occurrence, movement and vertical distribution of ground water; Water bearing geological formations; Springs, classification of aquifers, renewable and non- renewable groundwater resources; hydrologic properties of rocks: porosity; permeability; specific yield; specific retention, hydraulic conductivity, transmissivity, storage coefficient. 8 hrs
- Unit 2** Groundwater quality: Physical and chemical properties of water, quality criteria for different uses, groundwater quality in different provinces of India, Groundwater contamination; hydrographs; water table contour maps; hydrostratigraphic units, Radioisotopes in hydro geological studies. 8 hrs
- Unit 3** Theory of groundwater flow: Darcy's law and its applications; types of wells, drilling methods, construction, design, development and maintenance of wells. 8 hrs
- Unit 4** Methods of artificial groundwater recharge; method of rainwater harvesting, problem of over exploitation of groundwater; groundwater legislation; water management in rural and urban areas, salt water intrusion in coastal aquifers; surface and sub surface geophysical and geological methods of groundwater exploration. 8 hrs

Environmental Geology

- Unit 5** Earth and its Environment: Introduction; Lithosphere, Hydrosphere and Atmosphere. Lithosphere; Earth's interior, structure and composition of Earth's crust, constituents of Earth's material. Soil Erosion; Soil profile, causes and effects of soil erosion, silting of estuaries, soil conservation 8 hrs
- Unit 6** Hydrosphere: Global water distribution, surface water bodies, glaciers, hydrological cycle and its components – precipitation, interception, runoff, evaporation and evapotranspiration. Water pollution and its effects on environment. 8 hrs
- Unit 7** Atmosphere: Earth's atmosphere - structure and composition. Layer-wise characteristics, evolution of the atmosphere, atmospheric pollution. 8 hrs
- Unit 8** Natural hazards: Earthquake, volcanic eruption, landslide, salt water encroachment, river flooding and drought. 8 hrs

Books for Reference:

1. Groundwater – C. F. Tolman – McGraw-Hill Book Co. Inc.
2. Groundwater Hydrology (2nd Ed.) – D. K. Todd, John Wiley and Sons Inc. New York
3. Hydrology – S. N. Davis and R. J. M. Dewiest – John Wiley and Sons Inc. New York.
4. Groundwater Resources Evaluation-W.C. Walton- McGraw-Hill Book Co. New York
5. Hydrogeology (2nd ed.) – C.W. Fetter – Merrill Publishing Co. U.S.A.
6. Handbook of Applied Hydrology-V.T.Chow (Ed) – McGraw-Hill Book Co. New York
7. Hydrogeology – K. R. Karanth – Tata McGraw Hill Publishing Co. Ltd.
8. Ground Water Assessment, Development and Management – K. R. Karanath – Tata McGraw Hill Publishing Co. Ltd.
9. Groundwater – H. M. Raghunath – Wiley Eastern Limited
10. Hydrology – H. M. Raghunath – Wiley Eastern Limited
11. Elements of Hydrology – V. P. Singh
12. Engineering Hydrology – K. Subramaniam – Tata McGraw Hill Publishing Co. Ltd.
13. Introduction to Hydrology – Viessman, W., Lewis, G. L. and Knapp, J. W. (3rd ed.) Harper and Row, New York
14. Applied Hydrology – Mutreja, K. N. – Tata McGraw Hill Publishing Co. Ltd.
15. Physical Geology -C. W. Montgomery-Wm. C. Brown Publishing Co. Ltd
16. Ecology, Environment & Pollution-A. Balasubramaian (1995) M/s. Indira Publishers, Mysore.
17. Atmosphere, Weather and Climate: An introduction to Meteorology-Narora-S. B. Saunders Co., Philadelphia
18. Physical Geology -A. N. Strahler
19. Meteorology - William L. Donn (1975) - McGraw-Hill Book Co., New York.
20. An introduction to Dynamic Meteorology - J. R. Holton (1992) - III Ed, Academic Press.
21. R.W. Tank: Focus on Environmental Geology (p.256)



MG 454: ATMOSPHERIC SCIENCE & PHOTOGRAMMETRY

Meteorology

- Unit 1** Important principles of meteorology and atmospheric science their significance for understanding the weather of the Earth. Sun and Earth relationships. Insolation: latitudinal and seasonal variations of insolation. Fundamental processes regulating meteorological processes: Temperature: latitudinal, seasonal, interannual variations of temperature. Winds- geostrophic, regional and local winds. Land-sea breezes. Atmospheric air pressure, air masses of the globe. Air masses, jet streams, cyclones, and ENSO and other related phenomena. 8 hrs
- Unit 2** Precipitation and Monsoon meteorology: Humidity, fog, mist dew, hail and snow. Rainfall, measurements and its distribution. Meteorology of India with special reference to the seasonal distributions of temperature, humidity, wind and precipitation. Onset and withdrawal of monsoons. Weather monitoring, and modifications and meteorological hazards: Thunder storms, dust storms, cyclones and related processes, floods, drought and famine, and hazards from aircrafts/space crafts. 8 hrs

Climatology

- Unit 3** Climatology: Fundamental principles causing climate variability. Distinguish between meteorology and climatology. Human's impact on climate change. Classification of continental & oceanic climates, and factors regulating climate: Koppen's and Thornthwaite's scheme of classification. Climatic zones of India. Climate change and climate cycles: short-term and long-term climate cycles: Tectonic, orbital and sub-orbital/rapid climate. 8 hrs
- Unit 4** Paleoclimatology: Principles of climatology. Tools for studying paleoclimate: Records and archives for studying paleoclimate: continental sediments, speleothems, ice cores, tree rings, desert varnish. Proxies for studying paleoclimate. 8 hrs

Photogrammetry

- Unit 5** Fundamentals of Photogrammetry and Aerial Photography: History, aerial cameras, aerial films and processing. Types of aerial photos, scale, ground coverage, planning for aerial photographs, flight procedures, planning and execution of photographic flights, radiometric characteristics. Principles and Applications of Aerial Photography: 8 hrs

- Unit 6** Principles and fundamentals of aerial photo interpretation, 8 hrs
Applications of aerial photography in geology. Fundamentals and geometry of aerial photos, relief and tilt displacements, mosaics and types of mosaics, stereoscopy, image displacement due to relief, concepts of stereo-photogrammetry, normal vision, depth perception and vertical exaggeration.
- Unit 7** Digital photogrammetry and interpretation techniques: definition, 8 hrs
creation of digital images, automatic measurements, automatic surface modeling, aerial triangulations, digital photogrammetric workstation.
- Unit 8** Satellite Photogrammetry. Use of ERDAS Leica Photogrammetry 8 hrs
suite in terrain analysis. Principle keys to interpretation of aerial photographs. Qualitative and quantitative determination of resource data. Elements of aerial photo interpretation: tone, colour, texture, pattern, shape, size and associated features, geotechnical analysis and convergence of evidence. Aerial photo interpretation in resource evaluation – geomorphology, lithology, geological structures.

Books for Reference:

1. Physical Geology - C. W. Montgomery-Wm. C. Brown Publishing Co. Ltd
2. Ecology, Environment & Pollution - A. Balasubramaian (1995) M/s. Indira Publishers, Mysore.
3. A Course in Elementary Meteorology – Meteorological Office Publications.
4. Atmosphere, Weather and Climate: An introduction to Meteorology-Narora-
5. S. B. Saunders Co., Philadelphia
6. Physical Geology -A. N. Strahler
7. Meteorology - William L. Donn (1975) - McGraw-Hill Book Co., New York
8. An introduction to Dynamic Meteorology - J. R. Holton (1992) - III Ed, Academic Press.
9. Manual of Photo Interpretation – American Society of Photogrammetry.
10. Remote Sensing and Image Interpretation – T. M. Lillesand and R. W. Kiefer – John Wiley and Sons.
11. Remote Sensing and Photogrammetry, vol. 1 and vol. 2 – M. L. Jhanwar and T. S. Chouhan – Vignan Prakasan, Jaipur.
12. Applied Remote Sensing and Photo Interpretation – T. S. Chouhan and K. N. Joshi – Vignan Prakasan, Jaipur.
13. Photogeology and Image Interpretation – Shiv N. Pandey – Wiley Eastern, New Delhi.
14. Fundamentals of Photogeology, Geomorphology – Verstappen – TTC Holland.

MG 455: STRUCTURAL GEOLOGY AND PALAEONTOLOGY LAB

Structural Geology (Lab)

1. Preparation of topomap, calculation of slope; drawing a profile.
2. Determination of strike and dip; Strike-whole-circle bearing and quadrant systems.
3. Representation of planar structures through strike and dip.
4. Representation of linear structures through strike and pitch.
5. Measurement of strike and dip using compass clinometer & brunton compass in the field.
6. Tracing the outcrop patterns of horizontal, vertical and inclined (dip & slope in opposite directions; dip & slope in the same direction – dip > slope, dip < slope) beds keeping the topography constant.
7. Drawing cross section of horizontal, folded, faulted and vertical beds/igneous intrusions, strata with unconformities using structural geological maps.
8. Completion of outcrops (three–point problems).
9. Problems involving thickness of bed (vertical and true), width of outcrop, strike, dip etc. Use of equal area and stereo-nets.

Palaeontology (Lab)

1. Invertebrate Fossils: Identification and descriptive morphology of Coelenterata Brachiopoda Mollusca, Arthropoda and Echinodermata.
2. Plant Fossils: Identification and descriptive morphology of plant fossils.
3. Microfossils: Descriptive morphology, classification and identification of microfossils.
4. Chronological ordering of invertebrate fossils, plant fossils and microfossils.
5. Evolutionary trends in fossils.
6. Reconstruction and identification of fossils aided by morphological parts.
7. Identification of microfossils and shells in the sediment samples collected by students.

MG 456: HYDROGEOLOGY, GEO-STATISTICS & C A (Lab)

Hydrogeology (Lab)

1. Study of Hydrogeological maps.
2. Preparation of Isohyetal maps and calculation of depth of rainfall.
3. Calculation of Potential evapotranspiration.
4. Calculation of Actual evapotranspiration
5. Calculation of water budget/water balance.
6. Determination of aquifer parameters.
7. Calculation of Specific capacity of dug wells and bore wells.
8. Generation of hydrogeomorphological maps.

Geo-statistics and Computer Applications (Lab)

1. Mean, median and mode.
2. Quartiles, deciles and percentages.
3. Correlation co-efficient, regression analysis and skewness.
4. Measures of dispersion and other basic statistical parameters.
5. Cluster analysis, factor analysis and contouring.
6. Use of application software (MS Excel, SPSS, Minitab etc.) for graphical representation of statistical data and construction of bar diagrams, pie diagrams, rose diagrams histograms, scatter plots etc.
7. Programming languages and operating systems. Power Point slide preparation.
8. Computer aided design and graphics.
9. Components of a computer (hardware & software), Input-output devices (storage devices). Evolution of computers. Principles of data processing: Word processing,
10. Programming languages and operating systems. Flow chart, Algorithm.

THIRD SEMESTER

MG 501: GEOSCIENCES (Elective Paper)

Unit 1	Introduction to Geosciences, Earth and its environment - lithosphere, hydrosphere and atmosphere.	8 hrs
Unit 2	Geological Agents and hazards: Weathering, Erosion, Transportation and Deposition. Volcanoes, Earth quake, Land slide, Salt water intrusion, Floods and draughts.	8 hrs
Unit 3	Structure and composition of the Earth: Crust, Mantle and ore. Geomorphology: Description of Earth surface features. Land forms, Physical divisions of India.	8 hrs
Unit 4	Structural Geology: Primary secondary structures, secondary structures-folds, faults, joints and unconformities.	8 hrs
Unit 5	Geological time scale, origin and evolution of life, fossils and fossilization.	8 hrs
Unit 6	Natural Resources: Water as a resource. Origin, occurrence and distribution of oil and gas. Minerals, rocks, soil as natural resources.	8 hrs
Unit 7	Oceanography : Geological, physical, chemical and biological Oceanography. Ocean floor morphology.	8 hrs
Unit 8	Physical properties of sea water, waves, tides currents, composition of sea water, primary, secondary & tertiary producers, food cycle and food pyramid. Coastal protection and management.	8 hrs

Books for Reference:

1. Fundamentals of Historical Geology and Stratigraphy of India, Ravindrakumar New Age International Pub.
2. Principles of Paleontology – Raup and Stanley – CBS Publications
3. Principles of Invertebrate Paleontology – Shrock and Twenhofel – CBS
4. Fossil Invertebrates, Cambridge Univ.- Lehmann, U and Hilmer, G. (1983)
5. Micropalaeontology, George Allen and Unwin -Brasier M.D. (1980)
6. Micropalaeontology, Graham & Trotman - Bignot, G. (1985)
7. An introduction to Paleobotany - Arnold, Chester R
8. Field Geology – McGraw Hill Book Co. - Lahee, F.H. (1961)
9. Structural Geology – 3rd edition, Prentice Hall - Billings M.P. (1977)
10. Principles of Engineering Geology - McGraw Hill – Krynine, D.P. Judd, W.P. (1957)
11. Principles of Petrology – G. W. Tyrell, Asia Pub. House, New Delhi
12. Igneous and Metamorphic Petrology – Turner and Verhoogen, CBS Publications
13. Sedimentary Rocks, CBS Pub. – F. J. Pettijohn (1984)
14. Stratigraphy and Sedimentation, W.H. Freeman – Krumbein and Sloss (1963)
15. Economic Mineral Deposits – Bateman
16. India's Mineral Wealth - Oxford Univ. Press - Brown and Dey (1975)
17. Indian Mineral Resources – Kirshnaswamy
18. Industrial Minerals & Rocks of India - Allied Publishers - Deb, S. (1987)
19. Hydrogeology – K. R. Karanth – Tata McGraw Hill Publishing Co. Ltd.
20. Groundwater – H. M. Raghunath – Wiley Eastern Limited
21. Elements of Hydrology – V. P. Singh
22. Courses in Mining Geology – R.N.P. Arogyaswamy, Oxford & IBH Publishing Co.
23. Field Geology – Crompton.

MG 502: REMOTE SENSING & Geographical Information System (GIS)

REMOTE SENSING

- Unit 1 Basic Concepts and Fundamentals of Remote Sensing:** History and concepts, advantages of remote sensing over conventional and aerial photography. Data acquisition and data analysis. Electromagnetic spectrum Energy sources and radiation principles, energy interactions in the atmosphere, energy interactions with the earth surface features, Spectral reflectance of vegetation, soil and water. 8 hrs
- Unit 2 Earth Resource Satellites:** Earth resource satellites, introduction, early history of space imaging, platforms (ground, aerial and space) and sensors. Earth Observation Satellites Landsat, SPOT, NOAA, SEASAT, IKONOS, Quickbird, Orb view etc. Indian Remote sensing programs: IRS satellite missions and their capabilities, INSAT series 8 hrs
- Unit 3 Principles of Thermal and Microwave Remote Sensing:** Introduction, Black Body radiation, Temperature Radiations from the earth surface, Study of Thermal Properties like thermal conductivity, thermal capacity, thermal inertia, apparent thermal inertia. Thermal Scanners. Applications of thermal Remote Sensing. Basic concepts of microwave remote sensing, Real Aperture Radars and Synthetic Aperture Radars, Microwave sensors, Interferometry. Applications of Microwave Remote Sensing 8 hrs
- Unit 4 Remote Sensing Applications:** In Earth Sciences – Geological interpretation- identification and mapping of litho-units, structural mapping, geohydrological mapping and engineering geology, geomorphologic mapping, geoenvironmental studies, mineral exploration. Land use and Land cover classification system; Applications of remote sensing in Oceanography - monitoring littoral processes, suspended sediments and shoreline change detection studies, Applications of satellite data for weather forecasting, meteorological and climatic studies such as cloud drift, precipitation, temperature, tropical cyclone and radiation budget. 8 hrs

Geographical Information System

- Unit 5 Data and information:** Types of geological and natural resources data, spatial and time variant, oriented information. Basics of Geographic Information System: Definition, components, packages, capabilities and purpose of GIS. Graphics and working with images, Internet browsing and web technology. 8 hrs
- Unit 6 Map Concept:** Map features, scale, resolution, accuracy, projection and database extent. Map Projection and parameters: Geographical co-ordinate system, spheroid and spheres. Types of projection and parameters. Geospatial Data Models: Spatial and non-spatial 8 hrs

databases. Vector and Raster models. Triangulated Irregular Network (TIN) model. Feature data formats and spatial data capturing techniques. GIS Databases: Generation of database, Database Management System (DBMS), DBMS Architecture and Model.

Unit 7 Digitisation, Editing and Structuring of Map Data: Mode of digitization, editing, topology creation and structuring map data. Data Quality and Sources of Errors: Nature of geographic data, sources of errors in GIS database, data quality parameters, handling errors in GIS. Digital Elevation and Terrain Models (DEM & DTM): Generation and structure of DEM/DTM and their applications. GIS Analysis and Presentation of Results: Basic analytic operations in GIS, tabular operations and analysis in GIS. 8 hrs

Unit 8 Global Positioning System (GPS): GPS satellites and receivers. Application and limitations of GPS. 8 hrs

Books for Reference:

1. Remote Sensing and Image Interpretation – T. M. Lillesand and R. W. Kiefer – John Wiley and Sons
2. Remote Sensing and Photogrammetry, vol. 1 and vol. 2 – M. L. Jhanwar and T. S. Chouhan – Vignan Prakasan, Jaipur
3. Applied Remote Sensing and Photo Interpretation – T. S. Chouhan and K. N. Joshi – Vignan Prakasan, Jaipur
4. Remote Sensing in Geology – P. S. Siegal and A. R. Gillespie – John Wiley
5. Remote Sensing and its applications to Geology - Drury, John Wiley & Sons
6. Remote Sensing – Sabins, John Wiley & Sons
7. Manual of Remote Sensing - American Society of Photogrammetry
8. Geographical Information System: A Guide to Technology – John C. Antenucci – Van Norstrand Reinhold Publications
9. Principles of Geographical Information System for Land Resource Assessment – P. A. Burrough – Oxford University Press
10. Computers: Concepts and Uses – Mary Summer - Prentice Hall
11. The Hardware Bible – Winn L. Roseh – BPB Publications, New Delhi.
12. Computer Fundamentals - P K Sinha BPB
13. Introduction to computers - N Subramanian TMH
14. Understanding computers - R Rajagopalan TMH
15. Multi media bible Indianapolis - Winn L Rosch 1995
16. Multimedia making it work - Osborne McGraw - Tay Vaughan Hill, 1998
17. Digital computer fundamentals Sixth Ed. McGraw Hill, 1991 - Thomas C Bartee
18. Computers today - Donald Sanders MGH
19. Computers today - Suresh K Basandra Galgotia
20. Computer concepts and applications, McGraw - Donald H Sanders Hill, 1987
21. Outline of theory and problems of data processing - Martin M Schaum's
22. McGraw Hill international book company - Lipschutz and Seymour Lipschutz:, 1998
23. Manual of Photo Interpretation – American Society of Photogrammetry
24. Photogeology and Image Interpretation – Shiv N. Pandey – Wiley Eastern, New Delhi
25. Fundamentals of Photogeology, Geomorphology – Verstappen – TTC Holland.

MG 503: OCEANOGRAPHY - I

Physical Oceanography

Unit 1	Wind generated waves in the oceans; their characteristics; shallow and deep water waves. Propagation, refraction, reflection and diffraction of waves. Wave spectrum, principles of wave forecasting. Mixing processes in the oceans; characteristics of important water masses. Tide-producing forces and their magnitudes; prediction of tides by the harmonic method; tides and tidal currents in shallow seas and estuaries.	8 hrs
Unit 2	Factors influencing coastal processes; transformation of waves in shallow water; effects of stratification; effect of bottom friction, littoral currents; wave action on sediment movement; rip currents; beach stability, ocean beach nourishment; harbour resonance; seiches; tsunami; interaction of waves and structure.	8 hrs
Unit 3	The global wind system; action of wind on ocean surface; Ekman's theory; Sverdrup, Stommel and Munk's theories; upwelling and sinking with special reference to the Indian ocean. Inertial currents; divergences and convergences; geostrophic motion; barotropic and baroclinic conditions; oceanic eddies, relationship between density, pressure and dynamic topography; relative and slope currents.	8 hrs
Unit 4	Wind driven coastal currents; typical scales of motion in the ocean. Characteristics of the global conveyor belt circulation and its causes. Formation of subtropical gyres; western boundary currents; equatorial current systems; El Nino; monsoonal winds and currents over the North Indian Ocean; Somali current; Upwelling process in the Arabian Sea. Estuaries: classification and nomenclature; estuarine circulation and mixing; depth – averaged and breadth – averaged models; sedimentation in estuaries; salinity intrusion in estuaries; effect of stratification; coastal pollution; mixing and dispersal of pollutants in estuaries and near-shore areas; coastal zone management.	8 hrs

Chemical Oceanography

Unit 5	Introduction to Chemical Oceanography: Principles and processes regulating the Composition of seawater – Primary and secondary inputs. Rivers, atmosphere, hydrothermal and sedimentary diagenesis.	8 hrs
Unit 6	Constancy of ionic composition of seawater. Distribution, sources and sinks for major minor, trace and extremely low trace elements in the oceans.	8 hrs
Unit 7	Distribution of radionuclides and gases in the oceans for understanding water column and sedimentary particles scavenging in the oceans.	8 hrs
Unit 8	Dissolved gases- carbon dioxide, oxygen, methane, and oxides of nitrogen in the oceans. Biogeochemistry of the oceans and importance of biological pump in regulating the composition of the atmosphere.	8 hrs

Reference books:

1. ISBN: 978-0-7506-3384-0. The Open University Set Book (Second Edition) 314pp.
2. Paul R. Pinet (1992) Oceanography: An introduction to the Planet Oceanus, West Publ., Co. 571pp.
3. Emerson, E and Hedges, J. (2008) Chemical Oceanography and the Marine Carbon Cycle. Cambridge University Press.
4. Riley, J. P. and Chester, R. 1971. Introduction to Marine Chemistry, Academic Press,
5. Chemical Oceanography, Vol. 1- 10 (2nd Ed.) - J. P. Riley and G. Skirrow, eds, Academic Press (1975–1989).
6. Fasham, Michael J.R. (2003) Ocean Biogeochemistry. The Role of the Ocean Carbon.
7. Cycle in Global Change Series.
8. Komar, P. D., (1976) Beach Processes and Sedimentation, Prentice-Hall. 429pp.
9. Reddy M.P.M. (2001) Descriptive Physical Oceanography, AA Balkema Press 440p.
10. Shepard, F.P. (1963), Submarine Geology. 2nd. ed. New York: Harper Row.557p.
11. Shepard, F.P. (1937), Retrieved classification of marine shoreline. J. Geology 45: 602-24.



MG 504: OCEANOGRAPHY – II

Geological Oceanography

- Unit 1** Introduction to Geological Oceanography. Classification of coasts: Valentin's Coastal Classification. Description of Beaches and palaeobeaches, Sea Stacks, Sea Caves and Notches. 8 hrs
- Unit 2** Ocean morphology: Description of Continental shelf, slope, rise and abyssal plains. Mid-oceanic ridges, Subductive zones and description of trenches, Ocean basins, Island arcs, Hot spots, Transform faults and Triple junctions. Description of Barren Island. Ocean floor Sediments: Biogenous, Cosmogenous, Hydrogenous, Terrigenous. 8 hrs

Biological Oceanography

- Unit 3** **Introduction to Biological Oceanography** - Planktons and harmful algal blooms. Diversity index and its use in biological oceanography, food webs. Case-I and Case-II oceanic water characteristics. Introduction to benthos, coral reefs, Introduction to Foraminifers, Diatoms, Ostracods and Dinoflagellates. 8 hrs
- Unit 4** Outlines of Microbenthos, Meiobenthos, and Macrobenthos in the oceans. Chl-a distribution in oceans. Contents of ocean related TSM fractions. Sampling methods and introduction to Hyperspectral spectroradiometers, use of spectrophotometers with integrated spheres. Secchi discs, D.O meters, Salinometers etc. Multiparametric Ocean probes to record salinity, temperature, chlorophyll, Dissolved oxygen. Presentation of data. 8 hrs

Marine Resources

- Unit 5** **Introduction:** Importance and classification – biotic and abiotic resources. Polymetallic nodule deposits: Introduction – First discovery nodules from different environments Distribution; Morphology: Internal structure; mineralogy; geochemistry; accretion rate; genesis. Hydrothermal sulfides: Introduction; Geological setting, genesis-hydrothermal activities, direct/indirect evidences, hydrothermal circulation, black and white smokers, mineralogy; geochemistry; ancient analogues; exploration methods; implications and future impacts of the discovery of massive sulfides. 8 hrs
- Unit 6** **Metalliferous sediments:** Introduction, definition, characteristics, geological setting, genesis; occurrences; ancient analogues; Red Sea deposits – geology, history of exploration/discovery, details of deposits, Red Sea Joint Commission, mining operations, beneficiation, tailings disposal; Bauer Deep Deposits. Phosphorites: Introduction; geological setting and occurrences; associations; form; mineralogy; geochemistry; environments of modern phosphorite deposition; controls on phosphorite formation; genesis - inorganic precipitation & replacement theories, long-term conversion of disseminated deposits. 8 hrs

- Unit 7 Ocean-energy resources:** Introduction, importance, general characteristics; Tidal energy-potential, harnessing, special features 8 hrs
tidal power plants in operation/under active consideration; the Indian scenario; Wave energy-potential. Special characteristics, the Indian scenario-potential, IIT-Madras wave energy programme “oscillating water column” chamber, Ocean Energy Thermal Conversion-Principle, factors affecting OTEC, special features, land-based/grazing types of plants.
- Unit 8 Placers:** Introduction - Characteristics, placer minerals, classification, 8 hrs
environments of placer mineral deposition - rivers, beaches and offshore areas; Sand as a resource. **Law of the Sea Treaty:** Introduction, UNCLOS I, II and III, Los Treaty – demarcation of various zones (Territorial Sea, Contiguous Zone, Exclusive Economic Zone, Legal Continental Shelf, High Sea, International Area of the Seabed), rights of coastal nations International Seabed Authority.

Reference books:

1. Carol M. Lalli and Timothy R. Parsons (1997) Biological Oceanography: An Introduction.
2. Miller, C.B. (2004) Biological Oceanography. Blackwell Publishers. 416pp.
3. Paul R. Pinet (1992) Oceanography: An introduction to the Planet Oceanus, West Publ., Co. 571pp.
4. Thruman, H. V. (1994) Introductory Oceanography. 7th Ed. Macmillan Pub., Co.
5. George Karleskint, Richard Turner, James Small, (2012) Introduction to Marine Biology Publisher: Brooks Cole, 512 pp.
6. Fasham, Michael J.R. (2003) Ocean Biogeochemistry The Role of the Ocean Carbon Cycle in Global Change Series.
7. Carter, R.W.G., and Orford, J.D. (1984) Coarse elastic barrier beaches: a discussion of the distinctive dynamic and morpho-sedimentary characteristics. Marine Geology 60: 377-89.
8. Carter, R.W.G., and Orford, J.D. (1984) Coarse elastic barrier beaches: a discussion of the distinctive dynamic and morpho-sedimentary characteristics. Marine Geology 60: 377-89.
9. Komar, P. D., (1976) Beach Processes and Sedimentation, Prentice-Hall. 429p.
10. Reddy M.P.M. (2001) Descriptive Physical Oceanography, AA Balkema Press. 440p.
11. Seibold and Berger: The seafloor.
12. Renard: Geology, Resources and Society.
13. R.A. Horne: Marine Chemistry (p.444)
14. G.S. (1989): Marine minerals in the Ocean. JGSI, 34:182-192
15. D.S. Cronan: Underwater minerals.
16. An Open University Course Team (1989): Seawater: Its composition, properties and behaviour (pp.33)
17. Bhandari et al. (ed.): Petroliferous basins of India.
18. Bjorlykke K. (1989): Sedimentology and Petroleum Geology.
19. Abdulin: Petroleum and Natural Gas Production.
20. Sidorov: Petroleum and Natural Gas wells (p.35).
21. G.S. Roonwal: Petroleum Resources-Indian Ocean.

MG 505: REMOTE SENSING & GIS (Lab)

Remote Sensing (Lab)

1. Numerical problems on aerial photographs.
2. Mosaic compilation, annotation, scaling and preparation of photo Index
3. Interpretation of Aerial photographs
4. Satellite Image Interpretation: Visual interpretation of Black & White and FCC images.
5. Plotting of spectral reflectance curves for vegetation, soil and water
6. Generation of Thematic maps like geology, geomorphology, Land use / land cover. Hydro-geomorphology etc.
7. Photo-base determination
8. Digital Image processing – Importing and exporting, Image enhancement and Image classification of satellite images using ERDAS Imagine software

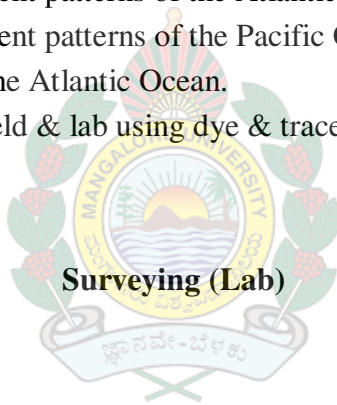
GIS (Lab)

1. Georeferencing – image rectification based on co-ordinate system.
2. Onscreen digitization
3. GIS and Remote Sensing data integration. Integration of vector and raster data (linking of spatial and non - spatial data)
4. Overlay analysis and proximity analysis.
5. Edge matching/ spatial adjustment
6. Calculation of slope in degrees and percentages.
7. Calculation of area, perimeter and distance using ArcGIS
8. Map composition and presentation of results
9. Digital elevation model – Digital topographic maps. Cut and fill problems in civil and military engineering. Aspect maps.
10. Creation of 3 – D TINS with ArcGIS
11. Network analysis in GIS – Oriented towards planning, administering and operational management resource facilities.

MG 506: PHYSICAL OCEANOGRAPHY AND SURVEYING (Lab)

Physical Oceanography (Lab)

1. Representation of annual wave period percentage frequency of the given region in the form of bar-diagram/histogram and its study.
2. Representation of wave direction data in the form of rose diagram and their study.
3. Interpretation of wave climate for the given data.
4. T-S diagrams
5. CSS diagram and study of waves.
6. Wave forecasting and Wave refraction study.
7. Observation and study of different wave breaker types.
8. Study of waves during rough and fair weather seasons.
9. Preparation and study of tidal curves
(mean tidal range, spring and neap tidal range - for different months).
10. Calculation of velocity of sound using Nomograph.
11. Study of major surface current patterns of the Indian Ocean.
12. Study of major surface current patterns of the Atlantic Ocean
13. Study of major surface current patterns of the Pacific Ocean
14. Deep ocean circulation in the Atlantic Ocean.
15. Littoral drift study in the field & lab using dye & tracer techniques.



1. Chain survey
2. Plane table survey
3. Leveling survey
4. Compass survey
5. Total station survey

FOURTH SEMESTER

MG 551: Dissertation

Each student is required to undertake a project work under the supervision of a faculty member. The project may be experimental, field investigation, laboratory studies, a theoretical investigation accompanied by computational work, data processing and analysis or a combination of these. After the dissertation work is completed, students shall submit dissertation/thesis based on the results obtained. The dissertation is evaluated by internal and external examiners. 300 marks

Viva -Voce

Each student has to present the dissertation work carried out by him/her in front of the examiners (internal and external) and the Chairman of the department. 100 marks

Field Work

Fortnightly field works carried out by the students under the guidance of faculty members will be evaluated by all the concerned teachers. 100 marks

Field Report

The main geological field work conducted by the students under the supervision of faculty member(s) will be evaluated by the concerned teacher(s). 50 marks