MANGALORE UNIVERSITY

DEPT. OF MARINE GEOLOGY

M.Sc. MARINE GEOLOGY SYLLABUS (CHOICE BASED CREDIT SYSTEM)

STRUCTURE OF THE COURSE

Programme Outcome:

Marine Geology is one of the disciplines of science deals with the origin and evolution of ocean basins including exploration and exploitation. Nevertheless, the M.Sc course in Marine Geology curriculum has been prepared to help students to perform better not only in competitive exams, such as UGC NET, Geologist positions in Geological Survey of India (GSI); Central Ground Water Board (CGWB), Oil and Natural Gas Corporation (ONGC) and Atomic Minerals Directorate (AMD); National Geophysical Research Institute (NGRI); Indian Space Research Organisation (ISRO); Groundwater, Mines and Geology Department of State Governments, and multinational corporations etc., but also research opportunities in Post-Doctoral research in various universities, research & development institutions and CSIR in India, private institutions, and multinational corporations and overseas labs./universities. Students can go for research and apply for faculty positions in engineering, post-graduate departments/universities.

Programme Specific Outcomes

The following Table provides various papers prescribed in the course along with important course outcome:

Students after gaining the knowledge in the field of Marine Geology can share theoretical and practical knowledge, which is required in teaching and research. Student can develop the ability to apply professional ethics, and accountability.

Semester	Course Theory / Lab	Instruction hrs/Week Lectures / Practicals	Duration of Exams (hrs)	Marks			Credits
				IA	Exam	Total	
First Semester : Five Hard Cores and One Soft Core							
MGH 401	Mineralogy and Geochemistry	4	3	30	70	100	4
MGH 402	Petrology	4	3	30	70	100	4
MGH 403	Stratigraphy and Paleontology	4	3	30	70	100	4
MGP 404	Mineralogy and Geochemistry (Lab)	8	3	30	70	100	4
MGP 405	Petrology (Lab)	8	4	30	70	100	4
MGS 406	Geomorphology and Geodynamics	3	3	30	70	100	3
			Semester Total			**600**	**23**

Second Semester : Two Hard Cores, Four Soft Cores and One Open Elective							
MGH 451	Structural Geologyand Hydrogeology	4	3	30	70	100	4
MGP 452	Structural Geology and Palaeontology (Lab)	8	3	30	70	100	4
MGS 453	Environmental Geology	3	3	30	70	100	3
MGS 454	Meteorology and Climatology	3	3	30	70	100	3
MGS 455	RS & Photogrammetry	3	3	30	70	100	3
MGP 456	Hydrogeology and Geostatistics & Comp. Appl. (Lab, soft core)	6	4	30	70	100	3
MGE 457	Geo-sciences (Open Elective)	3	3	30	70	100	3
					Semester Total	**700**	**20 + 3**
Third Semester : Two Hard Cores, Five Soft Cores and One Open Elective							
MGH 501	Oceanography - I (Physical & Chemical)	4	3	30	70	100	4
MGH 502	Oceanography - II (Geol & Biological)	4	3	30	70	100	4
MGS 503	Exploration and Engineering Geology	3	3	30	70	100	3
MGS 504	Economic Geology and Mining Geology	3	3	30	70	100	3
MGS 505	GIS and GPS	3	3	30	70	100	3
MGP 506	Remote Sensing and GIS (Lab, soft core)	6	3	30	70	100	3
MGP 507	Physical Oceanography and Surveying (Lab, soft core)	6	4	30	70	100	3
MGE 508	Ocean & Atmospheric Science (Open Elective)	3	3	30	70	100	3
					Semester Total	**800**	**23 + 3**
Fourth Semester :							
MGP 551	Project Work - Dissertation					300	12
	Viva - Voce					100	4
	Field Work and Field Report					100	4
					Semester Total	**500**	**20**
					Grand Total	**2600**	**86+6***

MGH 401: MINEROLOGY AND GEOCHEMISTRY

Course Outcome:

CO1: Chemical, physical, electrical, magnetic and thermal properties of minerals are understood.
CO2: Helps to identifying mineral resources for sustainable development.
CO3: Important in understanding cycling of elements and minerals in different compartments of the earth and helps to understand the origin of elements and their abundance in the universe.
CO4: Can describe the chemical and geochemical classification of elements and able to explain the composition of planets and earth's interior.

Mineralogy

Unit 1	Introduction to crystallography: Crystal systems and Elements of symmetry (32 classes). Principles of X-ray diffraction and its applications.	4 hrs
Unit 2	Introduction and Principles of Mineralogy: Definition and importance of minerals for sustainable development. Properties of minerals: chemical, physical, electrical, magnetic and thermal.	4 hrs
Unit 3	Principles of optical mineralogy: Introduction to optical mineralogy, polarized light and crossed nicols. Behaviour of isotropic and anisotropic minerals, refractive index, double refraction, birefringence, sign of elongation, interference figures, 2V, dispersion in minerals. Classification of minerals based on optical properties. Ore and ore forming minerals.	8 hrs
Unit 4	Descriptive Mineralogy:Silicates-Structural classifications. Description of major rock forming mineralsof the following groups;Olivine, Pyroxene, Amphibole, Garnet, Mica, Feldspar, Quartz, Aluminosilicate, Zeolites, Clay minerals.	10 hrs

Geochemistry

Unit 5	Introduction to geochemistry and cosmochemistry: Origin of elements and their abundance in the universe. Structure and atomic properties of elements, Periodic Table. Chemical and geochemical classification of elements. Meteorites and their applications. Composition of planets and earth's interior.	6 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.	6 hrs
Unit 7	Biogeochemistry: Introduction and the current relevance of biogeochemistry. Principles of geochemical cycle including human activity in altering the earth system. Bio-geochemical cycles of carbon, nitrogen and phosphorous.	6 hrs
Unit 8	Isotope geochemistry and principles of geochronology. Radioactive, stable isotopes and fission products; and their classifications and applications in different fields of the earth science. Stable isotopes, their fractionation and their applications in different fields of the earth science with special reference to paleoclimate.	8 hrs

List of References:

1. Rock Forming Minerals – Deer, Howie and Zussman: Longman Publishers (1983).
2. Text Book of Mineralogy – J. D. Dana, E. S. Asia Publ House (1985).
3. Elements of X-ray Crystallography – Azaraoff
4. Elements of Mineralogy – Rutley – CBS Publications
5. Elements of Optical Mineralogy – Winchell, Wiley eastern Limited (1937).
6. Mineralogy – Berry I. G. and Masson, B. Freeman and Co. (1959).
7. Introduction to Geochemistry – Krauskopf, E. B. McGraw Hill (1979).
8. Principles of Geochemistry – Brain Massan, Wiley eastern limited (1958).
9. Inorganic Geochemistry – Henderson P (1982) – Oxford – Pergamon.
10. Geochemistry – Goldchmidt, B. M. (1958).
11. Geochemistry – Hammer Fmiza (2008).

MGH 402: PETROLOGY

Course Outcome:

CO1: Identify various minerals formed in igneous rocks and interpret geologic history of igneous rocks based on mineral assemblages and texture.
CO2: To make students confident of their ability to "read" rocks.
CO3: Assign a name to an igneous, sedimentary and metamorphic rocks based on mineralogical and textural characteristics.
CO4: Quarring, mining and science disciplines, mines and geology departments and, academic and research institutions

Igneous Petrology

Unit 1	Magma and its properties: magma, its generation in the crust and mantle, physical and chemical properties. Bowen's reaction series. Magmatic Evolution: partial melting, magmatic differentiation fractional crystallization, liquid immiscibility, magma mixing and assimilation.	8 hrs
Unit 2	Forms and structures of igneous rocks. Classification of igneous rocks - IUGS and other standard classifications. Textures of igneous rocks.	6 hrs
Unit 3	Distribution and description of important igneous rocks: Granite, basalt, syenite, peridotite, carbonatite, dolerite, lamprophyre, kimberlite and their associated mineral deposits with special reference to India.	6 hrs

Sedimentary Petrology

Unit 4	Sources and formation of sediments. Textures and primary structures of sedimentary rocks.	6 hrs
Unit 5	Diagenesis. Classification of sediments and sedimentary rocks.	6 hrs
Unit 6	Distribution and description of important sedimentary rocks:Rudites – Breccia and conglomerate; Arenites - sandstones, greywacke; Argillites – shale, Carbonates - limestone and dolomite.	8 hrs

Metamorphic Petrology

Unit 7	Metamorphism: Introduction, definition and types, ocean-floor metamorphism, diagenesis vs. metamorphism. Factors of metamorphism: temperature, pressure and fluids.	6 hrs
Unit 8	Textures and structures of metamorphic rocks: Lineation and Foliation, Grades of metamorphism.Gneisses, granulites, quartzites, schists, slates and marbles.	6 hrs

List of References:

1. Sedimentary Petrology F. J. Pettijohn (2004).
2. Petrology of sedimentary rocks – Greensmith (1989).
3. Depositional Sedimentary environments, Springer–H.E. Reineck and I.B. Singh
4. Principles of Petrology – G. W. Tyrell, Asia Pub. House, New Delhi (1980).
5. Petrology – Ehlers and Blatt, CBS Publ (2006).
6. Igneous and Metamorphic Petrology – Best Myron G., CBS Publications (1986).
7. Students Petrology – Allen and Nockolds (1978).
8. A Practical Approach to Sedimentology - CBS Pub. – R.C. Lindholm (1987).
9. Sedimentary Rocks, CBS Pub. – F. J. Pettijohn (1984).
10. Petrology- Igneous, Sedimentary and Metamorphic (3rd Edition): Harvey Blatt, Robert J. Tracy, Brent E. Owens - Allied Publishers.
11. Igneous rocks and Processes: Practical Guide by robin Gill - Willey Blackwell.
12. Petrology of Sedimentary Rocks: Boggs Sam- CUP.

MGH 403: STRATIGRAPHY AND PALAEONTOLOGY

Course Outcome:

CO1: Familiarise with historical geology, correlate various rock formations or stratigraphic sections.
CO2: A detailed understanding of stratigraphy of India will be acquired.
CO3: Can describe various theories on origin of life, organic evolution, mass extinctions and their causes.
CO4: Explain the theory of biological evolution and how it explains the distribution, diversity, and extinction of organisms.
CO5: Can understand types of fossils, fossilisation and conditions required for preservation of fossils.

Stratigraphy

Unit 1	Introduction:Principles of stratigraphy, 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. A brief review of global stratigraphy.	8 hrs
Unit 2	Physiographic and tectonic subdivisions of India; Evolution of the Indian subcontinent since the Archaean Eon.	4 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 Plain and Himalaya.	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.	6 hrs

Palaeontology

Unit 5	Introduction. Theories on origin of life. Organic evolution, mass extinctions and their causes. 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). Applications of fossils in stratigraphic correlation.	8 hrs
Unit 6	Invertebrate and Vertebrate fossils - Morphology, classification, evolution, age and stratigraphic importance of Porifera, Coelenterata, Brachiopoda, Mollusca, Arthropoda and Echinodermata. Siwalik vertebrate fauna.	6 hrs
Unit 7	Palaeobotany: Evolution of plant life, plant fossils and fossilization. Gondwana and Tertiary flora. Description of Algae, Spores and Pollen.	6 hrs
Unit 8	Micropalaeontology: Extraction of microfossils from sediments. Microfossil groups: Foraminifera, Ostracoda, Acritarcha, Radiolaria, Diatoms. Nannoplankton and Dinoflagellates. Applications of microfossils and trace fossils in Earth Sciences, Environmental significance and in hydrocarbon exploration.	8 hrs

List of References:

1. Stratigraphic Principles and Practice - M .J. Weller (1960).
2. Fundamentals of Historical Geology and Srtatigraphy of India by Ravindrakumar - New Age International Publication.
3. Stratigraphy and Sedimentation, W.H. Freeman – Krumbein and Sloss (1963).
4. Principles of Paleontology – Raup and Stanley – CBS Publications.
5. Principles of Invertebrate Paleontology – Shrock and Twenhofel – CBS Publications.
6. Elemental Geosystem - Printice Hall, Inc.- R.W. Christopherson (1995)
7. The dynamic Earth: An introduction, Skinner & S.C. Porter, John Wiley and Sons.
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. Sedimentology and Stratigraphy: Gary Nichols - Willey Blackwell.

MGP 404: MINERALOGY & GEOCHEMISTRY (Lab)

Course Outcome:

CO1: A megascopic study of important rock forming minerals is achieved.
CO2: Able to determine the physical and chemical properties of natural water and helps to know the chemistry of sediments and water.
CO3: Practical knowledge/hands on experience will help students to perform field work and geologic investigations where they work.

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 water.
4. Measurements of hardness, calcium and magnesium carbonates.
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.

MGP 405: PETROLOGY (Lab)

Course Outcome:

CO1: Will be able to identify the igneous, sedimentary and metamorphic rocks (hand specimen)
CO2: Helps to understand various mega structures, textures and mineralogy of igneous, sedimentary and metamorphic rocks.
CO3: Practical knowledge will help students to do field work and geologic investigations where they work.

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.

MGS 406: GEOMORPHOLOGY AND GEODYNAMICS

Course Outcome:

CO1: Understand processes of weathering and erosion.
CO2: Identify and describe different types of mass movements and various causes of mass movement.
CO3: Describe geologic processes in relation to plate tectonics and continental drift.
CO4: Able to identify geologic structures created by deformation and geomorphic features formed over various landforms.
CO5: Various geomorphic features associated with various geomorphic agents can be distinguished.

Geomorphology

Unit 1	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 2	Basic principles. Concepts of gradation, types of weathering and mass wasting. Concept of erosion cycles. Geomorphology of fluvial tracts, arid zones, coastal regions, Karst landscapes and glacial regions.	6 hrs
Unit 3	Applied Geomorphology: Flood management. Applications of geomorphology in mineral prospecting, Geomorphology of India with special reference to Karnataka.	6 hrs

Geodynamics

Unit 4	Introduction to Geodynamics. Seismic zones of India. Paleomagnetism: Polar wandering curve and magnetic reversals.	6 hrs
Unit 5	Plate Tectonics: Concept of Plate Tectonics. Major and minor plates. Mechanism of plate motion, Mantle convection. Rift Valleys.	6 hrs
Unit 6	Continental Drift: Concept and different lines of evidence. The concept of the Super continent - Gondwanaland and its fragments. Vertical Tectonics: Introduction to Vertical tectonics. Concept of Isostasy.	8 hrs

List of References:

1. Physical Geology - Wm and C Brown - Montgomery, C.W. (1990)
2. An introduction to Coastal Geomorphology - Pethick, J. (1984), Edward Arnold, London, 259p.
3. Process Geomorphology, 5th edition - Ritter, D.F., R.C. Kochel and J.R. Miller (2011). McGraw Hill, NY. Rental text.
4. Global Geomorphology: An introduction to the study of landforms - Summerfield, M.A. (Editor), (1991). John Wiley and Sons Ltd., New York: 560p.
5. Principles of Geomorphology - Thornbury, W.D. (1969): Wiley Eastern Limited, New Delhi: 594 p.
6. A short history of Geomorphology - Tinkler (1985), Croom-Helm, London.
7. Fundamentals of Geomorphology - Rice (1998).
8. Introduction to Geomorphology - Kale & Gupta (2001).
9. The Evolving Continents - Brain F. Windley (1977), John Wiley & Sons. 385p.
10. The Geology of Continental Margins - Springler Verlag, NY - Burk C. A. & Drake, C. L. (1974).
11. Plate tectonics and Crustal Evolution - Condie, K.C. Pergamon Press, 288p.
12. Elemental Geosystems A foundation in Physical Geography - Christopherson, R. W. (1995) Printice Hall Inc., 580p.
13. Magnetic anomalies over ocean ridges - Vine, F. J., and Matthews, P. M. (1963) Nature, 199, 947-949.
14. The Interior of the Earth - Bott, M.H.P. (1982), Arnold, London, 316pp.
15. The Afro-Arabian Rift System - Khan, M. A., (1975). Sci. Prog.62, 207-236.
16. McElhinny, (1973) Palaeomagnetism and Plate Tectonics. Cambridge Univ. Press, 358p.
17. Ramachandra Rao, M. B. (1975). Outlines of Geophysical Prospecting: A manual for Geologist E.B.D. Educational Pvt. Ltd. Dehra Dun. 403p.
18. Parasnis, D. S. (1979). Principles of applied Geophysics. Chapman and Hall, - 275p.
19. Dobrin, M.B. (1976). Introduction to Geophysical Prospecting. New York McGraw-Hill, 630p.
20. Geodynamics Elsevier - Artyushkov E.V. (1983)
21. The Dynamic Earth - John Wiley - Skinner, B.J. and Porter, S.C. (1995)
22. Earth Dynamics - BLOCK 4, The Open University Press - Open University Series (1982)
23. Earth Structure - BLOCK 2. The Open University press (1982) - Open University Series.
24. 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.
25. Geophysics: Annette Bolger- Oxford Book Company: SalvadariGlanfausta et al- Springer.
26. Introduction to Coastal Processes & Geomorphology: Robin Davidson – Arnott - CUP.

SECOND SEMESTER

MGH 451: STRUCTURAL GEOLOGY & HYDROGEOLOGY

Course Outcome:

CO1: Earth's Hydrologic cycle is understood.
CO2: Understand the occurrence movement and distribution of water that is a prime resource for development of a civilization..
CO3: Able to understand components of groundwater system, artificial groundwater recharge methods etc.
CO4: Students will be able to use various ground water exploration techniques.
CO5: Identifying zones of mineral concentrations, water resources and harvesting, and mining

Structural Geology

Unit 1	**Introduction:** Importance ofstructural geology and its relationship with other branches of geology. Dip and strike. **Force, stress and strain:** Force and acceleration, composition and resolution of forces. Concept of stress and strain; strain analysis using deformation objects.	6 hrs
Unit 2	**Folds:** Parts of a fold. Geometrical classification of folds. Mechanics and causes of folding. Criteria for recognition of folds in the field.	6 hrs
Unit 3	**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.	6 hrs
Unit 4	**Joints:** Geometry and classification. Field studies, importance of joints in geological, structural/civil engineering studies. **Unconformities:** Different types of unconformities. Recognition of unconformities in the field. Criteria to differentiate between faults and unconformities.	8 hrs

Hydrogeology

Unit 5	**Introduction:** Origin of water, hydrological cycle and its components – precipitation, interception, runoff, evaporation and evapotranspiration. types, importance, occurrence, movement and vertical distribution of ground water; Water bearing geological formations; Springs, classification of aquifers, hydrologic properties of rocks: porosity; permeability; specific yield; specific retention, hydraulic conductivity, transmissivity, storage coefficient. Darcy's law and its applications.	10 hrs
Unit 6	**Groundwater quality:** Physical and chemical properties of water, quality criteria for different uses, groundwater quality provinces of India, Groundwater contamination; water table fluctuation, water table contour maps; hydrostratigraphic units.	6 hrs
Unit 7	**Wells:** Types, drilling methods, construction, design, development and maintenance. Salt water intrusion in coastal and island aquifers; groundwater legislation in rural and urban areas.	4 hrs
Unit 8	Groundwater development and management: Methods of artificial groundwater recharge; rainwater harvesting, problems of over-exploitation of groundwater; water management in rural and urban areas, geological and geophysical methods of groundwater exploration.	6 hrs

List of References:

1. Field Geology – McGraw Hill Book Co. - Lahee, F. H. (1961)
2. Folding and Fracturing of Rocks - McGraw Hill Book Co. - Ramsay, J.G. (1967)
3. Structural Geology – 3rd edition, Prentice Hall - Billings M.P. (1977)
4. Structural Geology of Rocks and Regions - John Wiley & Sons - Davis, G.H. (1984)
5. Structural Geology Principles, Concepts and Problems, 2nd Edition, New Jersey Prentice Hall - Hatcher, Robert D. (1995)
6. Structural Geology – W.H. Freeman, New York - Twiss, Robert J. (1992)
7. Structural Geology – McGraw Hill - Timothy Whetten (1975)
8. Knighton, D. (1998). Fluvial forms and processes: A new Perspective, Arnold, London, 385p.
9. Morisawa, M. 1985. Rivers, Longman, London 222p.
10. Murthy, K.S. 1998. Watershed management in India, 3rd edition, Wiley Eastern Ltd. New Age International Ltd, New Delhi, 198 p.
11. Groundwater – C. F. Tolman – McGraw-Hill Book Co. Inc.
12. Groundwater Hydrology (2nd Ed.) – D. K. Todd, John Wiley and Sons Inc. New York
13. Hydrology – S. N. Davis and R. J. M. Dewiest – John Wiley and Sons Inc. New York.
14. Groundwater Resources Evaluation - W.C. Walton - McGraw-Hill Book Co. New York
15. Hydrogeology (2nd ed.) – C.W. Fetter – Merrill Publishing Co. U.S.A.
16. Handbook of Applied Hydrology - V.T. Chow (Ed) – McGraw-Hill Book Co. New York
17. Hydrogeology – K. R. Karanth – Tata McGraw Hill Publishing Co. Ltd.
18. Ground Water Assessment, Development and Management – K. R. Karanath – Tata
19. McGraw Hill Publishing Co. Ltd.
20. Groundwater – H. M. Raghunath – Wiley Eastern Limited
21. Hydrology – H. M. Raghunath – Wiley Eastern Limited
22. Elements of Hydrology – V. P. Singh
23. Engineering Hydrology – K. Subramaniam – Tata McGraw Hill Publishing Co. Ltd.
24. Introduction to Hydrology – Viessman, W., Lewis, G. L. and Knapp, J. W. (3rd ed.) Harper and Row, New York
25. Applied Hydrology – Mutreja, K. N. – Tata McGraw Hill Publishing Co. Ltd.
26. Global Groundwater Resources & Management: Paliwal - Scientific publishers.
27. Exploitation of Groundwater and their effects: Noor M. - Cyber Tech Publishers
28. Hydrology: Gautam Mahajan - Ashish publishers.

MGP 452: STRUCTURAL GEOLOGY AND PALAEONTOLOGY LAB

Course Outcome:

CO1: Preparation of topomap, calculation of slope, drawing profiles etc. is attained.
CO2: Determination of strike and dip; Strike-whole-circle bearing and quadrant systems. Representation of planar structures through strike and dip.
CO3: Helps to study and describe various invertebrate fossils,
CO4: Practical knowledge will help students to do field work related to exploration of water, minerals and fossils to trace evolution and in search of fossil fuels.

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 stereonets.

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.

MGS 453: ENVIRONMENTAL GEOLOGY

Course Outcome:

CO1: Explain how earth processes create hazards to life and property.

CO2: Describe the major sources of water, soil, and sediment pollution and methods for their management.

CO3: Explain the causes and effects of geological hazards: Earthquake, volcanic eruption, landslide, droughts, floods

CO4: Describe and identifying the human induced problem of the environment.

Environmental Geology

Unit 1 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 profile, Soil Erosion - causes and effects, silting of estuaries and reservoirs, soil conservation measures. 8 hrs

Unit 2 Hydrosphere: Global water distribution, Surface water bodies, glaciers, Water pollution – surface water, groundwater, marine water and their impacts. Hydrographs. 8 hrs

Unit 3 Atmosphere: Earth's atmosphere - evolution, structure and composition. Layer-wise characteristics, causes and effects of atmospheric pollution – acid rain, global warming, greenhouse effect, urban heat islands and heat wave. 8 hrs

Unit 4 Geological hazards: Earthquake, volcanic eruption, landslide, droughts, floods - their significance, causes, preparedness and mitigation. Seismic zones of India. CRZ Act and Coastal zone management. 8 hrs

Unit 5 Environmental considerations related to civil engineering and mining projects. A few case studies. 8 hrs

List of References:

1. Physical Geology – Foster Robert, J. (1975).
2. Ecology, Environment & Pollution - A. Balasubramaian (1995) M/s Indira Publishers, Mysore.
3. Atmosphere, Weather and Climate: An introduction to Meteorology – Narora, S. B. Saunders Co., Philadelphia.
4. Physical Geology - A. N. Strahler
5. R.W. Tank: Focus on Environmental Geology (p.256)
6. Disaster Management: Dr. Ranita Nagar - APH publishers.
7. Disaster Management: 3 Volumes set - APH publishers.
8. Management of Natural and Man-made Disasters: Aradhana Salpekar – Jnanadha Prakashana.
9. Future Disasters: Dr. Priya Ranjan Trivedi - The Global Open University.
10. Management of Flood, Tropical Cyclones, Storms: Kadambari Sharma – Jnanadha Prakashana.
11. Landslides types Mechanism and Modelling: J. Clague and Douglas Stead.
12. Fundamentals of Weather and Climate. 2nd ed.: Mcilveen and Robin - OUP
13. Marine Pollution Control and Management: Dr. Tanmoy – Jnanadha Prakashana.
14. Water Pollution: Tripathi- Ashish Publishers.
15. Water: Characteristics and Properties: Neelima Rajavaidya - APH Publishers.

MGS 454: METEOROLOGY AND CLIMATOLOGY

Course Outcome:

CO1: Able to understand the elements of meteorology and their significance.

CO2: Understand precipitation and its types, temperature, atmospheric pressure, winds and humidity. Earth's radiation balance and human interference: relationships between the Earth and the Sun.

CO3: Able to learn weather monitoring, meteorological hazards and weather modification: Thunder storms, dust storms, cloud burst, cyclones and related processes, floods, drought and famine .

CO4: Understand the general weather systems of India.

Meteorology

Unit 1 Elements of meteorology and their significance. Precipitation and its types, temperature, atmospheric pressure, winds and humidity. Earth's radiation balance and human interference: relationships between the Earth and the Sun. Latitudinal, altitudinal and seasonal variations in the temperature including lapse rate. Atmospheric boundary layer and turbulence. Coupled ocean-atmosphere system, El Nino Southern Oscillation (ENSO). 6 hrs

Unit 2 Descriptive meteorology: Winds- geostrophic, and distribution of global winds, regional and local winds, land-sea breezes. Atmospheric pressure and air masses of the globe. Introduction to the global monsoons, jet streams, tropical cyclones and other related phenomena. Monsoon meteorology. Rainfall, measurements and its distribution over the globe with special emphasis on India. Onset and withdrawal of monsoons. General weather systems of India. 6 hrs

Unit 3 Weather monitoring, meteorological hazards and weather modification: Thunder storms, dust storms, cloud burst, cyclones and related processes, floods, drought and famine, and pollution/hazards from aircrafts and space crafts. General weather systems of India, - cyclone and jet stream, Western disturbances and severe local convective systems, distribution of precipitation over India. Western disturbances and severe local convective systems. Utilities of satellites in meteorology. 8 hrs

Climatology

Unit 4 Principles of climatology: Differences between meteorology and climatology. Intergovernmental Panel on Climate Change.Causes of climate variation: tectonic (changes in the redistributions of continents and oceans), orbital (changes in the solar output) and sub-orbital parameters, including human factors (Changes in the concentration of Greenhouse Gases in the atmosphere). 6 hrs

Unit 5 Climate system and feedbacks. Classification of continental and oceanic climates : Greeks, Koppen's and Thornthwaite's schemes of classification. Climate and climatic zones of India. Principles of General Circulation and Climate Modelling. 6 hrs

Unit 6 Paleoclimatology: Principles of paleoclimate. Sources, records and proxies for paleoclimate. Records for paleoclimate – instrumental / meteorological data and archives: continental and oceanic sediments, speleothems, loess, ice cores, corals, tree rings, desert varnish. Proxies for paleoclimate - stable and radiogenic isotopes, trace elements, pollen, clay minerals, and microfossils. Short-term and long terms variations in the climate. Climate change and, short-term and long-term climate cycles. 8 hrs

List of References:

1. Physical Geology - C. W. Montgomery-Wm. C. Brown Publishing Co. Ltd.
2. Physical Geology – Judson Sheldon (1987).
3. Ecology, Environment & Pollution - A. Balasubramaian (1995) M/s. Indira Publishers, Mysore.
4. A Course in Elementary Meteorology – Meteorological Office Publications.
5. Atmosphere, Weather and Climate: An introduction to Meteorology-Narora - B. Saunders Co., Philadelphia.
6. Meteorology - William L. Donn (1975) - McGraw-Hill Book Co., New York.
7. An introduction to Dynamic Meteorology - J. R. Holton (1992) - III Ed, Academic Press.
8. Climate Processes and Change Cambridge Univ. Press – E. Bryant (1997).
9. Intergovernmental Panel for Climate Change reports 2007, 2013 (available in the internet).

MGS 455: REMOTE SENSING & PHOTOGRAMMETRY

Course outcome:

CO1: Able to study history, basic concepts of data acquisition and data analysis, electromagnetic spectrum.
CO2: Can describe energy sources and radiation principles, energy interactions in the atmosphere, energy interactions with the earth surface features, spectral reflectance curves.
CO3: Able to do geological interpretation - identification and mapping of litho-units, structural mapping, geohydrological mapping, geomorphologic mapping.
CO4: Able to generate different kinds of thematic maps on various natural resources.

REMOTE SENSING

Unit 1	**Fundamentals of Remote Sensing:** History, basic concepts: 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 curves, spectral reflectance of various natural earth surface features like vegetation, soil and water.	5 hrs
Unit 2	**Earth Resource Satellites:** Introduction, early history of space imaging, POES and GOES series of satellites, platforms (ground, aerial and space) and sensors. Important earth observation satellites like Landsat, SPOT, NOAA, SEASAT, IKONOS, Quick bird, Orb view etc. Spatial, spectral, temporal and radiometric resolutions. Indian Remote sensing programs: IRS satellite missions and their capabilities, INSAT series. Advantages of satellite remote sensing.	5 hrs
Unit 3	**Principles of Thermal and Microwave Remote Sensing:** Introduction, Black body radiation, Temperature Radiations from the earth's surface, 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. Visual and digital image analysis techniques.	5 hrs
Unit 4	**Remote Sensing Applications:** In Earth Sciences – Geological interpretation- identification and mapping of litho-units, structural mapping, geohydrological mapping and engineering projects, geomorphologic mapping, geoenvironmental studies, mineral exploration, land use and land cover classification. In Oceanography - monitoring littoral processes, suspended sediments and shoreline change detection studies. In weather forecasting, meteorological and climatic studies such as cloud drift, precipitation, temperature, tropical cyclone and in understanding earth's radiation budget.	5 hrs

Photogrammetry

Unit 5	Fundamentals of aerial photography and photogrammetry: History, aerial cameras, aerial films and processing. Types of aerial photos. Fundamentals and geometry of aerial photographs, Scale, Advantages and disadvantages of small-scale and large-scale aerial photographs, relief and tilt displacements, mosaics and types of mosaics, stereoscopic vision and stereoscopes, image displacement due to relief, concepts of stereo-photogrammetry, normal vision, depth perception and vertical exaggeration.	5 hrs

Unit 6	Planning for aerial photographs, flight procedures, planning and execution of photographic flights, radiometric characteristics. Elements of aerial photo interpretation: tone, colour, texture, pattern, shape, size and associated features, geotechnical analysis and convergence of evidence.	5 hrs
Unit 7	Principles and Applications of Aerial Photography: Aerial photo interpretation in resource evaluation – geology, delineation of geological structures, mineral exploration and geomorphology.	5 hrs
Unit 8	Digital photogrametry and interpretation techniques: definition, creation of digital images, automatic measurements and surface modeling, aerial triangulations, digital photogrammetric workstation.	5 hrs

List of References:

1. Manual of Photo Interpretation – American Society of Photogrammetry.
2. Remote Sensing and Image Interpretation – T. M. Lillesand and R. W. Kiefer – John Wiley and Sons.
3. Fundamentals of Photogeology, Geomorphology – Verstappen – TTC Holland.
4. Remote Sensing and Photogrammetry, vol. 1 and vol. 2 – M. L. Jhanwar and T. S. Chouhan – Vignan Prakasan, Jaipur.
5. Applied Remote Sensing and Photo Interpretation – T. S. Chouhan and K. N. Joshi – Vignan Prakasan, Jaipur.
6. Remote Sensing in Geology – P. S. Siegal and A. R. Gillespie – John Wiley.
7. Remote Sensing and its applications to Geology - Drury, John Wiley & Sons.
8. Remote Sensing – Sabins, John Wiley & Sons.
9. Manual of Remote Sensing; American Association of Photogrammetry and Remote Sensing.
10. Photo geology and Image Interpretation – Shiv N. Pandey – Wiley Eastern, New Delhi.

MGP 456: HYDROGEOLOGY, GEO-STATISTICS & COMP APPL. (Lab)

Course Outcome:

CO1: Practical knowledge will help students to do field work related not only related to vast data of the earth and perhaps statistical tools to understand the system of changes.

CO2: Able to know different methods of collecting the hydrological information, which is essential, to understand surface and ground water hydrology.

CO3: To know the basic principles and movement of ground water and properties of ground water flow.

CO4: Basic knowledge of computation and measurements, and some knowledge on data sources and data analysis.

Hydrogeology (Lab, Soft Core)

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

MGE 457: GEOSCIENCES (Open Elective Course)

Course outcome:

CO1: Able to understand and learn the basics of Geology, Earth and its environment - lithosphere, hydrosphere, atmosphere, internal structure and various geological processes.

CO2: Attain knowledge of geological time scale, origin and evolution of life, fossils, fossilization and their applications.

CO3: Able to describe Earth's surface features, landforms, physical divisions of India.

CO4: Able to understand various natural resources.

Unit 1	Introduction to Geology, Earth and its environment - lithosphere, hydrosphere and atmosphere.	6 hrs
Unit 2	Geological time scale. Origin and evolution of life, fossils, fossilization and their applications.	6 hrs
Unit 3	Geological Agents and hazards: Weathering, Erosion, Transportation and Deposition. Volcanoes, Earthquake, Landslide, Salt water intrusion, Floods and droughts.	6 hrs
Unit 4	Geomorphology: Description of Earth surface features. Landforms, Physical divisions of India. Structure and composition of the Earth's interior: Crust, Mantle and Core.	6 hrs
Unit 5	Structural Geology: Primary structures, secondary structures - folds, faults, joints and unconformities.	8 hrs
Unit 6	Natural Resources: Renewable and non-renewable resources. Water as a resource. Origin, occurrence and distribution of oil and gas. Minerals, rocks. Soil. Economically and strategically important metallic and non-metallic mineral deposits of India.	8 hrs

List of References:

1. Fundamentals of Historical Geology and Srtatigraphy 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 Hilimer, 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. Field Geology – Crompton.
10. Structural Geology – 3rd edition, Prentice Hall - Billings M.P. (1977)
11. Principles of Engineering Geology - McGraw Hill – Krynine, D.P. Judd, W.P. (1957)
12. Principles of Petrology – G. W. Tyrell, Asia Pub. House, New Delhi
13. Igneous and Metamorphic Petrology – Turner and Verhoogen, CBS Publications
14. Sedimentary Rocks, CBS Pub. – F. J. Pettijohn (1984)
15. Stratigraphy and Sedimentation, W.H. Freeman – Krumbein and Sloss (1963)
16. Economic Mineral Deposits – Bateman
17. India's Mineral Wealth - Oxford Univ. Press - Brown and Dey (1975)
18. Indian Mineral Resources – Kirshnaswamy
19. Industrial Minerals & Rocks of India - Allied Publishers - Deb, S. (1987)
20. Hydrogeology – K. R. Karanth – Tata McGraw Hill Publishing Co. Ltd.
21. Groundwater – H. M. Raghunath – Wiley Eastern Limited
22. Elements of Hydrology – V. P. Singh
23. Courses in Mining Geology – R.N.P. Arogyaswamy, Oxford & IBH Publishing Co.

THIRD SEMESTER

MGH 501: OCEANOGRAPHY – I

Course Outcome:

CO1: Attain knowledge of the physics and chemistry of the oceans, atmospheric and oceanic circulation, climate and weather etc.

CO2: Understand 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.

CO3: Describe the principles involved in the generation of waves and tides and evaluate their effects on coastal processes and marine ecosystems.

CO4: Able to know various principles and processes regulating the composition of seawater – primary and secondary inputs. Rivers, atmosphere, hydrothermal and diagenesis

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.	6 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 with structures.	6 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.	6 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 and La Nina; 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.	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 diagenesis.	6 hrs
Unit 6	Constancy of ionic composition of seawater. Composition of seawater – Classification of elements based on their distribution; major and minor	6 hrs

	constituents; behavior of elements; chemical exchanges across river-sea, particulate-dissolved and sediment-water interfaces.	
Unit 7	Distribution of radionuclides and gases in the oceans for understanding water column and sedimentary particles scavenging in the oceans. Residence times of elements in seawater and processes regulating it.	6 hrs
Unit 8	Chemical and biological interactions – Ionic interactions; cycling and air-sea exchange of important biogenic dissolved gases; carbon dioxide-carbonate system; alkalinity and control of pH; abiotic and biotic controls of trace elements in the ocean; biological pump and controls on atmospheric composition.	8 hrs

List of References:

1. Principles of Oceanography - M. Grant Gross.
2. Oceanography – J.J. Bhat.
3. The Open University Set Book (Second Edition) 314p.
4. Pinet P. R. (1992) Oceanography: An introduction to the Planet Oceanus, West Publ., Co. 571p.
5. Emerson, E and Hedges, J. (2008) Chemical Oceanography and the Marine Carbon Cycle. Cambridge University Press.
6. Riley, J. P. and Chester, R. 1971. Introduction to Marine Chemistry, Academic Press,
7. Chemical Oceanography, Vol. 1- 10 (2nd Ed.) - J. P. Riley and G. Skirrow, eds, Academic Press (1975–1989).
8. Fasham, Michael J.R. (2003) Ocean Biogeochemistry. The Role of the Ocean Carbon.
9. Cycle in Global Change Series.
10. Komar, P. D., (1976) Beach Processes and Sedimentation, Prentice-Hall. 429p.
11. Reddy M.P.M. (2001) Descriptive Physical Oceanography, A A Balkema Press, 440p.
12. Shepard, F.P. (1963), Submarine Geology. 2nd. Ed. New York: Harper Row.557p.
13. Shepard, F.P. (1937), Retreived classification of marine shoreline. J. Geology 45: 602-24.
14. Schulz, H.D. and Zabel, M. (2006) Marine Geochemistry. Springer. 221p.
15. Coastal Engineering Processes: Dominic Reeve, Andrew Chadwick and Chris Fleming - Allied Publishers
16. Marines on the Beach: Christopher Paul - Allied Publishers. .
17. Coastal Processes with Engineering Applications: Robert A. Darylampe - Limited.
18. The Indian Ocean Tsunami: Karon Pradhyumna and Subbiah Shanmugham- Foundation.
19. Coastal Zone Management: United Nations Convention on Law of the Sea-Uncclos III: Ar.DushyantKamat - Jnanadha Prakash.
20. Coastal Hydrodynamics: J. S. Mani - PHI Learning Pvt Ltd.
21. Ocean Energy: R. H. Charlies & C. W. Finkl - Springer.
22. Coastal & Marine: Geospatial Tech David R. Green – Springer.
23. Glossary of Geoscience and Oceanography: Tanmaya Rudra - JnanadhaPrakashana.
24. Understanding Sea Level Rise and Variability: Church John A. - John Velly and sons.
25. Coasts, Marine Structures and Breakwaters: Adapting to change: Allsop N. W. H. - Telford, Thomas.
26. Indian Ocean Studies Cultural, Social & Political Perspectives: Shanta Murthi and Jamal Shraf - Routledge.

MGH 502: OCEANOGRAPHY – II

Course Outcome:

CO1: Students will be exposed to Geological Oceanography. Classification of coasts: Valentin's Coastal Classification. Description of Beaches and palaeo beaches, Sea Stacks, Sea Caves and Notches.

CO2: Attain knowledge of ocean floor morphology: Description of Continental shelf, slope, rise and abyssal plains. Explore oceans in search of living, minerals and fossil fuels as oceans cover more than two-thirds of the earth's surface.

CO3: Explain the relationship between plants and animals in the ocean and how they affect the cycling of matter and energy across the ocean, atmosphere and lithosphere.

CO4: Summarize the major physical and chemical properties of seawater and how each affects marine life.

Geological Oceanography

Unit 1	Introduction to Geological Oceanography. Classification of coasts: Valentin's Coastal Classification. Description of Beaches and palaeo beaches, Sea Stacks, Sea Caves and Notches. Ocean floor morphology: Description of Continental shelf, slope, rise and abyssal plains. Mid-oceanic ridge, Subduction zone and description of trenches, Ocean basins, Island arcs, Hot spots, Transform faults and Triple junction. Plate tectonics and Neotectonic processes.	8 hrs
Unit 2	Factors controlling the deposition and distribution of oceanic/marine sediments - Biogenous, Cosmogenous, Hydrogenous, Terrigenous and Authigenic. Tectonic evolution of the ocean basins. Reconstruction of monsoon variability by using marine proxy records. Opening and closing of ocean gateways and their effect on circulation and climate during the Cenozoic era. Sea-level change and methods to determine paleo-sea surface temperature.	8 hrs
Unit 3	Ocean-energy resources:Introduction, importance, general characteristics; Tidal energy-potential, harnessing, special features of 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.	6 hrs
Unit 4	Definition, characteristics, marine geological setting, genesis and occurrence of Metalliferous sediments**,** Phosphorites (including mineralogy and geochemical environments of modern deposition). Marine mineral resources:Importance, biotic and abiotic. Polymetallic nodules, Cobalt and other related crusts, Hydrothermal sulfide deposits including black and white smokers.	6 hrs
Unit 5	Placers: placer minerals, classification, 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,	6 hrs

High Sea, International Area of the Seabed), rights of coastal nations. International Seabed Authority.

Biological Oceanography

Unit 6	Introduction: Physico-chemical factors affecting marine life – light, temperature, salinity, pressure, nutrients, dissolved gases; adaptation and biological processes. Diversity index and its use in biological oceanography. Food-web. Case-I and Case-II water characteristics. Human impacts on marine communities; impacts of climate change on marine biodiversity. Impact of pollution on marine environments including fisheries.	6 hrs
Unit 7	Classification of the marine environment and marine organisms. Primary and secondary production; factors controlling phytoplankton and zooplankton abundance and its diversity. Plankton and harmful algal blooms. Nekton and introduction to fishery oceanography, benthos, coral reefs, foraminifera, diatoms, ostracods and dinoflagellates. Benthic organisms, coastal- marine communities. A glimpse of ecology – estuaries, coral reefs and mangrove, deep-sea including hydrothermal vent communities.	6 hrs
Unit 8	Outline of microbenthos, meiobenthos and macrobenthos in the ocean. Chlorophyll distribution in oceans. Sampling methods and introduct-ion to Hyperspectral spectroradiometer, use of spectrophotometer. Secchi disc, D.O meter, Salinometer etc. Multiparametric Ocean probes to record salinity, temperature, chlorophyll, Dissolved oxygen.	6 hrs

List of References:

1. Pinet, P. R. (1992) Oceanography: An introduction to the Planet Oceanus, West Publ., Co. 571p.
2. Komar, P. D. (1976) Beach Processes and Sedimentation, Prentice-Hall. 429p.
3. Reddy M.P.M. (2001) Descriptive Physical Oceanography, AA Balkema Press. 440p.
4. Seibold, E. and Berger: The seafloor (1982).
5. Horne, R.A. (1969) Marine Geology; the structure of water and the chemistry of the hydrosphere.
6. R.A. Horne: Marine Chemistry (p.444)Carol M. Lalli and Timothy R. Parsons (1997) Biological Oceanography: An Introduction.
7. Miller, C.B. (2004) Biological Oceanography. Blackwell Publishers. 416pp.
8. George Karleskint, Richard Turner, James Small, (2012) Introduction to Marine Biology Publisher: Brooks Cole, 512 p.

MGS 503: EXPLORATION AND ENGINEERING GEOLOGY

Course Outcomes:

CO1: Understand the role of geology in the design and construction of underground openings in rock.

CO2: Attain knowledge about the principles and applications of airborne, onshore and offshore exploration methods.

CO3: Able to apply geologic concepts and approaches on rock engineering projects and Understandvarious geophysical exploration techniques and well logging techniques

CO4: Able to understand construction of large-scale features/establishments, like dams, tunnels, rail,sub-marine pipelines, road and runways, ports, harbours and airports.

EXPLORATION GEOLOGY

Unit 1	Introduction: scope and objectives of exploration geology. General principles and applications of airborne, onshore and offshore exploration methods for understanding the structure of earth and in the exploration of water, fossil fuels and mineral deposits.	6 hrs
Unit 2	Geophysical Exploration: Principles, instrumentation, methodology and applications of onshore and offshore geophysical explorations - Gravity, magnetic, seismic, electrical and radioactive techniques. Well Logging Techniques: Electrical, Radioactive, Sonic and Miscellaneous. Echosounder and its uses.	6 hrs
Unit 3	Geological Exploration/Prospecting: Importance of geological and different types of maps. Various geological criteria for the identification of mineral deposits. Indications of ore body. Different methods of geological prospecting/exploration.	6 hrs
Unit 4	Geochemical and bio-geobotanical methods exploration:Geochemical and biogeochemical indicators of economically important ore deposits. Techniques of mineral exploration.Geobotanical prospecting: Importance of plants in identifying the ore deposits.	8 hrs

ENGINEERING GEOLOGY

Unit 5	Geological studies and evaluation in planning, design and construction of major civil structures. Engineering properties of rocks. Concepts of rock mechanics and soil mechanics. Physical characteristics of building materials.	6 hrs
Unit 6	Resource evaluation of construction materials. Geological investingations for dams, reservoirs and spillways, tunnels, underground caverns, bridges, highways and tunnels. Problems of groundwater in engg. projects. Remedial measures.	8 hrs

List of References:

1. Courses in Mining Geology – R.N.P. Arogyaswamy, Oxford & IBH Publ. Co. (1973)
2. Principles of Engineering Geology - McGraw Hill – Krynine, D.P. Judd, W.P. (1957)
3. Fundamentals of Engineering Geology - Butterworths – Bell F.G. (1983) Principles.
4. Engineering Hydrology – K. Subramaniam – Tata McGraw Hill Publishing Co. Ltd.
5. Anthony M. Evans (2006). Introduction to Mineral Exploration Blackwell II edition. (available in net)
6. Brain F. Windley (1977). The Evolving Continents John Wiley & Sons. 385p.
7. Burk, C.A. & Drake, C.L. The Geology of Continental Margins-Springler Verlag, NY (1974).
8. Condie, K.C. Plate tectonics and Crustal Evolution, Pergamon Press, 288p. (1989)
9. Christopherson, R. W. (1995). Elemental Geosystems A foundation in Physical Geography. Printice Hall Inc., 580p.
10. Vine, F. J., and Matthews, P. M. (1963). Magnetic anomalies over ocean ridges. Nature, 199, 947-949.
11. Bott, M.H.P., (1971). The Interior of the Earth. Arnold, London, 316p.
12. Khan, M. A., (1975). The Afro-Arabian Rift System.Sci. Prog.62, 207-236.
13. McElhinny, (1973). Palaeomagnetism and Plate Tectonics. Cambridge Univ. Press, 358p.
14. Ramachandra Rao, M. B (1975). Outlines of Geophysical Prospecting: A manual for Geologist E.B.D. Educational Pvt. Ltd., Dehra Dun.403p.
15. Parasnis, D. S. (1979). Principles of applied Geophysics. Chapman and Hall, - 275 p.
16. Dobrin, M.B. (1976). Introduction to Geophysical Prospecting. New York McGraw-Hill, 630p.
17. Introduction to Geophysical Prospecting - Milton B Dobrin (1981).
18. Exploration geophysics – Jakaosku J. J.
19. Outlines of geophysical prospecting - A manual for geologists – M B Ramachandra Rao.
20. Exploration Geophysics for Geologist and Engineers – Bhimasanakaranand Gaur
21. Geochemistry in mineral exploration Rose, A.W Hawkes, H.E & Webb J.S. 1979. Academic press.
22. Engineering and General Geology: P T Sawant- New India Publishers.

MGS 504: ECONOMIC GEOLOGY AND MINING GEOLOGY

Course Outcome:

CO1: Understand the origin of various ore deposits and their importance.
CO2: Various exploration and mining techniques are learnt.
CO3: Explore the earth in search of minerals and fossil fuels, and develop technologies for exploitation

Economic Geology

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

Mining Geology

Unit 7	Introduction, definition, aim, and scope of mining of natural resources. Methods of mining / quarrying: alluvial mining, open cast mining, loading, glory hole, kaoline mining, quarrying.	6 hrs
Unit 8	Underground mining methods - stopping and caving, coal and metallic mineral mining. Ventilation and mine supports.	4 hrs

List of References:

1. D.S. Cronan: Underwater minerals (1980).
2. Bateman, Economic Mineral Deposits (1979).
3. Brown and Dey, India's Mineral Wealth - Oxford University Press (1975).
4. Kirshnaswamy, Indian Mineral Resources
5. Skinner, Earth Resources (1995).
6. Deb, S., Industrial Minerals & Rocks of India (1987) - Allied Publishers.
7. W.H. Freeman and Park C.F. Ore Deposits (1975).
8. Sinha and Sharma. Mineral Economics (1980).
9. An Open University Course Team (1989): Seawater: Its composition, properties and behaviour (p. 33)
10. Bhandari, L. L. and Venkatachala, B.S. (Ed.): Petroliferous basins of India.
11. Bjorlykke K. (1984): Sedimentology and Petroleum Geology.
12. Abdulin, F.: Petroleum of Oil and Gas (1985).
13. Sidorov, N. A.: Drilling Oil and Gas wells (1985).
14. G.S. Roonwal: The Indian Ocean: Exploitable Mineral and Petroleum Resources (1986).
15. G.S. Roonwal (1989): Marine minerals in the Ocean. JGSI, 34:182-192.
16. Dictionary of Oil & Gas Production: Clifford Jones.
17. The Myth of the Oil Crisis: Robin M. Mills.
18. Petroleum Geochemistry: Satyanarayana- Daya Publishers.
19. A hand book of minerals, rocks and ores: Alexander. P.O (2009) - New India Publishing Agency.

MGS 505: GIS AND GPS

Course Outcome:

CO1: Students will be exposed to data and information, types of data - spatial and time variant.
CO2: Attain knowledge of Geographical Information System (GIS). Able to generate various databases.
CO3: Able to understand Global Positioning System (GPS), GPS system segments, GPS satellites and receivers. GPS-Error sources, measurements, accuracy and estimates of user position and time.
CO4: To understand the applicationsand limitations of GPS.

Geographical Information System

Unit 1	Introduction:Data and information: Types of data - spatial and time variant. Geographical Information System (GIS): Introduction, fundamentals and functions of GIS. Components of GIS. Generation of database, Database Management System (DBMS), DBMS Architecture and Model. Map Concept: Map features, scale, resolution and accuracy. Map Projection: Earth's size and shape in time and space. Spherical coordinates, Properties of map projections, Types of basic projections classification - Cylindrical, Conical and Azimuthal projections. UTM Coordinates.	8 hrs
Unit 2	Spatial Data Models:Raster and Vector models. Advantages and Disadvantages of Raster and Vector Models. Digitization, editing, topology creation and structuring of map data. Data quality and errors: Importance of Errors, Accuracy and Precision, Types of Errors, Sources of Inaccuracy and Impression, Problems of Propagation and Cascading, False precision and false accuracy, and dangers of undocumented data.	8 hrs
Unit 3	Spatial Analysis:Introduction, significance of spatial Analysis, spatial analysis tools in GIS. Vector Based - Various types of overlay analysis operations: Topological overlays, Polygon-in-polygon overlay, line-in-polygon overlay, Point-in-polygon overlay, Logical operations (Boolean operations), Conditional operations, Buffer analysis, Steps for performing Geographic analysis. Raster Based - Introduction, Advantages and disadvantages of raster analysis, Grid operations used in map algebra, important raster analysis operations, Grid based spatial analysis. Digital Elevation and Terrain Models (DEM & DTM): Generation and structure of DEM/DTM and their applications. Geospatial Triangulated Irregular Network (TIN) model. Introduction to network analysis and its Applications.	16 hrs
Unit 4	Global Positioning System (GPS): GPS system segments, GPS satellites and receivers. GPS-Error sources, Measurements, Accuracy and estimates of user position and time. Applicationand limitations of GPS.	8 hrs

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1. Remote Sensing and Image Interpretation – T. M. Lillesand and R. W. Kiefer – John Wiley and Sons
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12. Computer Fundamentals - P K Sinha BPB
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15. Multi-media bible Indianapolis - Winn L. Rosch 1995
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24. Photogeology and Image Interpretation – Shiv N. Pandey – Wiley Eastern, New Delhi
25. Fundamentals of Photogeology, Geomorphology – Verstappen – TTC Holland.
26. Elements of GPS: Nand Kishore Agrawal.
27. Geographic Information Analysis: Darid O, Sur - John Willey.
28. A Primer of GIS: Fundamental Geographic and Cartographic concept: Francis Harvey - Rawath Publisher.
29. Geoinformatics: G. Randy Keller & Chaithanya Bara - CUP
30. Remote Sensing in Geomorphology: Patrick Simon-Oxford Book Company.
31. Remote Sensing Techniques for Regional Development: Banarjee R. K- Concept Publishers.
32. Principles of Map Design: Tyner Judith A. - The Guil Ford Press.
33. Spatial Statistics and Spatio-Temporal Data: Covariance Functions and Directional Properties :Sheman Michael - John Velly and sons .
34. Remote Sensing in Geomorphology: S.M. Ramaswamy- New India.

MGP 506: REMOTE SENSING & GIS (Lab, Soft Core)

Course Outcome:

CO1: Students will be able to generate various kinds of thematic maps.

CO2: They will learn various software packages, which will be used for the analysis of remotely sensed data.

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. Extraction of Thematic maps: Road, Settlement, Drainage
5. Overlay analysis and proximity analysis.
6. Edge matching/ spatial adjustment
7. Calculation of slope in degrees and percentages.
8. Calculation of area, perimeter and distance using ArcGIS
9. Map composition and presentation of results
10. Creation of 3D maps: TIN, Hillshade, Aspect with ArcGIS

MGP 507: Physical Oceanography and surveying (Lab, Soft Core)

Course Outcome:

CO1: Practical knowledge will help students to do beach profiling.

CO2: Attain knowledge about field work related to beach dynamics, ocean survey and land surveys.

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.

Surveying (Lab)

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

MGE 508: Ocean & Atmospheric Science (Open Elective)

Course Outcome:

CO1: Attain knowledge about physical oceanography - Physical properties of sea water. Waves, tides and currents. Coastal protection and management

CO2: Understand chemical oceanography - Composition of seawater: Constancy of composition of seawater and its limitations. Distribution of elements in seawater and biogeochemical processes regulating the composition and climate change.

CO3: Introduction to atmospheric Science - Structure and composition of the atmosphere. Processes regulating the composition of the atmosphere, and human interference.

CO4: Students will understand various branches of Oceanography.

Oceanography

Unit 1	Physical Oceanography - Physical properties of sea water. Waves, tides and currents. Coastal protection and management.	6 hrs
Unit 2	Chemical Oceanography - Composition of seawater: Constancy of composition of seawater and its limitations. Distribution of elements in seawater and biogeochemical processes regulating the composition and climate change. Residence times of elements in the ocean and its importance. Tracers for understanding the present and past oceanographic processes.	6 hrs
Unit 3	Biological and Geological Oceanography - Introduction, classification of marine life. Primary, secondary and tertiary production. Planktonic and benthic life in the ocean. Diversity index and its use in biological oceanography, food-web. Geological oceanography: Origin and evolution of the ocean floor. Continental drift, sea-floor spreading and plate tectonics. Ocean morphological features, development and significance.	6 hrs
Unit 4	Marine mineral resources: Distribution and classification of minerals of economic importance in different oceanographic settings: Seawater as a source of elements/minerals. Placer and heavy mineral deposits, petroleum and coal, phosphorites, gas hydrates, poly-metalic nodules, metals enriched crusts, hydrothermal and metalliferous sediments.	6 hrs

Atmospheric Science

Unit 5	Introduction to atmospheric Science - Structure and composition of the atmosphere. Processes regulating the composition of the atmosphere, and human interference - Greenhouse effect, ozone hole and global warming. Introduction to meteorology and elements of the weather system.	8 hrs
Unit 6	Climatology and Paleoclimatology: Difference between weather and climate. Climate and its principles of classification. Climate change, climate cycles and tools/proxies for studying paleoclimatology.	8 hrs

List of Reference:

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20. Sidorov, N. A.: Drilling Oil and Gas wells (1985).
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FOURTH SEMESTER

Course Outcome:

CO1: Practical knowledge will help students to do field work related to beach dynamics, ocean survey and land surveys.

CO2: To get a sense of research, students are encouraged to do project work in different disciplines of earth, atmospheric and ocean research either in-house or outside the university, such as national institutes/ government/private firms. This will help students to get an idea about research to pursue further education/employment.

CO3: The knowledge gained in the field of Geoinformatics will be used to solve various earth related problems students will be sent to various research institutes like NIO, NCAOR, INCOIS, NGRI and ISRO to carry out the project dissertation work.

Field work:

Course Outcome:

CO1: Students have to visit various research institutes, to know/understand the latest advancements/development in the field of Geoinformatics.

CO 2: They have to visit the nearby areas for field work and later they have to generate the thematic maps in understand various geologic/geomorphic/coastal processes in a better way.

MGP 551: Project Work

Dissertation: Each student is required to undertake a project work under the supervision of faculty members during the entire tenure of the fourth semester. 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 above mentioned work. 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 examination committee comprising of Guide, Chairman of the department and external examiner(s).	100 marks
Field Work: All students must do detailed geological field work / participate in the ocean expedition under the guidance of faculty members immediately after the third semester. The faculty members will continuously evaluate the performance of the students during field work / ocean expedition.	50 marks
Field Report: A detailed report must be submitted immediately after the field work / ocean expedition to facilitate the students to devote the fourth semester time exclusively for dissertation. The report will be evaluated by the accompanied faculty member(s).	50 marks
Total	500 marks