

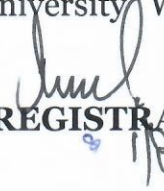
NOTIFICATION

Sub: Revised syllabus of M.Sc. in Marine Geology Programme.

Ref: Academic Council approval vide agenda No.: ಎಸಿಸಿ:ಶೈ.ಮ.ಸಾ.ಸ.1:1
(2025-26) dtd 18.07.2025.

The revised syllabus of M.Sc. in Marine Geology programme which has been approved by the Academic Council at its meeting held on 18.07.2025 is hereby notified for implementation with effect from the academic year 2025-26 and onwards.

Copy of the Syllabus shall be downloaded from the University Website (www.mangaloreuniversity.ac.in)


REGISTRAR

To,

1. The Registrar (Evaluation), Mangalore University.
2. The Chairman, PG Board of Studies in Marine Geology, Dept. of Marine Geology, Mangalore University.
3. The Chairman, Dept. of Marine Geology, Mangalore University.
4. The Asst. Registrar (ACC), O/o the Registrar, Mangalore University.
5. The Director, DUIMS, Mangalore University – with a request to publish in the website.
6. Guard File.

Mangalore University
Department of Marine Geology
Mangalagangothri-574199

**Revised syllabus for M.Sc. MARINE GEOLOGY (Choice Based Credit System)
with effect from Academic Year - 2025-26**

PREAMBLE

The primary objective of revising the 2023 syllabus is to comply with the directive No. MU/REG/SYN (S3)/12/2025-97261 dated 15-04-2025. Additionally, the revision is aimed at deepening students' understanding of the subject, incorporating recent advancements, and enhancing their skills, employability, and entrepreneurial capabilities.

The syllabus revised on 14th September 2023 has undergone further changes during the BoS meeting held on 30th May 2025. This revision addresses the challenges faced by both faculty and students regarding mismatches between theoretical subjects and corresponding practical in the first three semesters. Despite these changes, the core goals of skill development, employability, and entrepreneurship remain unchanged.

The structure of the Choice Based Credit System (CBCS), first introduced in 2016, with modifications in 2018 and further refined in the special BoS meeting on 28th January 2020, has been retained. Valuable inputs were provided during that meeting by Dr. N. Maran (Deputy Director-General, GSI & HOD, MCSD, Mangalore) and Dr. A.C. Dinesh (Director, MCSD, GSI, Mangalore), as well as other external BoS members.

The revised syllabus is designed not only to strengthen academic knowledge but also to contribute to social development. It emphasizes (a) keeping up with advancements across the subject's subfields, (b) promoting stronger student-teacher engagement, (c) encouraging internships both during vacations and post-class hours, (d) fostering student confidence and subject mastery, (e) supporting project work during the fourth semester at national institutions or multinational firms, and (f) improving performance in competitive exams and interviews, ultimately aiding students in securing employment, research opportunities, and international fellowships.

Programme learning outcomes

Marine Geology is one of the interdisciplinary branches of Earth Science that deals with the origin and evolution of ocean basins, including paleoclimate and paleoceanography, and natural resources exploration. Nevertheless, the course includes also the earth, atmospheric (meteorology and climatology) and ocean sciences including remote sensing and geographic information system (GIS), and global positioning system (GPS) in three semesters followed by intense fieldwork, visit to R & D laboratories/institutes related to the curriculum prescribed and carry out dissertation/project work in the IV semester. The outcomes of the programme of MSc in Marine Geology are given below:

- PO1 Acquiring of sustainable knowledge in different fields of earth, atmosphere and ocean sciences to take up any work related to the earth science.
- PO2 Skills development to learn, monitor and understand the spatio-temporal variability of vast data/big data pertaining not only to the earth system science but also those collected by satellites by using advanced remote sensing and processing data in geographic information system techniques.
- PO3 By learning major subjects of the programme, students can develop their skills in various fields which would help them to take up the work related to mineralogy, petrology, natural resources and different exploration techniques to tap water and mineral resources.
- PO4 Geoinformatics tools for monitoring, mapping and management of land, water, marine resources, urban planning, evaluation of natural disasters and geological and geomorphological studies. This knowledge will be useful to work on impact assessment and mitigation.
- PO5 Dissertation/project work either in the parent university or outside R & D labs, MNCs in any one of the aspects of the curriculum in order to help students to take up independent work after the course. This will help them in research / managerial positions in their employment career.
- PO6 Experience gained during fieldwork, visiting R & D labs and visiting Oceanographic Research Vessels / Ships will motivate students to choose the career after the M.Sc. course.

Programme specific outcomes

The syllabus of MSc, Marine Geology is quite unique as compared to other courses related to earth science, geology, geophysics, meteorology and oceanography, as it covers most of the syllabus prescribed for the NET and the UPSC geologist's examination. The successful students are able to get employment either in government (universities, undergraduate colleges, engineering institutes) and private companies including MNCs, research position in universities/research institutes. Based on the knowledge acquired over two years, students can start consultancies/take up an independent project as well as chances to get overseas research fellowships and employment.

The mapping of course outcomes (COs) and the programme specific outcomes is given in the following Table:

Course No.	Course title	POs as spelt out in the syllabus					
	COs as spelt out in the syllabus	1	2	3	4	5	6
1	Mineralogy and Geochemistry	✓		✓		✓	✓
2	Stratigraphy and Paleontology	✓		✓		✓	✓
3	Geomorphology and Geodynamics	✓		✓		✓	
4	Remote Sensing and Photogrammetry	✓	✓		✓	✓	✓
5	Mineralogy and Palaeontology (Lab, Hard core)	✓	✓	✓			✓
6	Remote Sensing and Geostatistics (Lab, Soft core)		✓		✓	✓	✓
7	Petrology	✓		✓	✓	✓	✓
8	Structural Geology and Hydrogeology	✓		✓	✓	✓	✓
9	Geographical Information System (GIS) and GPS	✓	✓		✓	✓	✓
10	Meteorology and Climatology	✓		✓		✓	✓
11	Economic Geology and Mining Geology	✓		✓		✓	✓
12	Petrology (Lab, Hard core)		✓	✓		✓	✓
13	Structural Geology, Hydrogeology and Basics of GIS (Lab, Hard core)		✓	✓	✓	✓	✓
14	Geo-Sciences (Open Elective)	✓	✓				
15	Oceanography-I (Physical and Chemical)	✓		✓	✓	✓	✓
16	Oceanography-II (Geological and Biological)	✓		✓	✓	✓	✓
17	Exploration, Engineering and Environmental Geology	✓	✓	✓		✓	✓
18	Applications of geoinformatics in geosciences (Lab, Soft core)	✓	✓		✓	✓	✓
19	Physical and Chemical Oceanography (Lab, Hard core)		✓	✓	✓	✓	✓
20	Geological Field Work and Field Report (Lab, Hard core)	✓	✓	✓	✓	✓	✓
21	Ocean and Atmospheric Science (Open Elective)	✓	✓		✓		
22	Dissertation and Viva-Voce	✓	✓	✓	✓	✓	✓

Mangalore University
DEPARTMENT OF MARINE GEOLOGY
M.Sc. MARINE GEOLOGY SYLLABUS (Choice Based Credit System)
with effect from Academic Year 2025 - 26

Structure of the M.Sc. Marine Geology Programme

Semester	Course (Theory and Practical)	The ory/ Prac tical	Durat ion of Exam (hrs)	Marks			Credits
				IA	Exam	Total	
I Semester - 2 Hard core (T), 2 Soft core (T),1 Hard core (P) and 1 Soft core (P)							
MGH-101	Mineralogy and Geochemistry	4	3	30	70	100	4
MGH-102	Stratigraphy and Paleontology	4	3	30	70	100	4
MGS-103	Geomorphology and Geodynamics	3	3	30	70	100	3
MGS-104	Remote Sensing and Photogrammetry	3	3	30	70	100	3
MGP-105	Mineralogy and Palaeontology (Lab, Hard core)	8	4	30	70	100	4
MGP-106	Remote Sensing and Geostatistics (Lab, Soft core)	6	3	30	70	100	3
I Semester Total		28	19	180	420	600	21
II Semester - 2 Hard core (T), 3 Soft core (T), 2 Hard core (P) and 1 Open Elective (E)							
MGH-151	Petrology	4	3	30	70	100	4
MGH-152	Structural Geology and Hydrogeology	4	3	30	70	100	4
MGS-153	GIS and GPS	3	3	30	70	100	3
MGS-154	Meteorology and Climatology	3	3	30	70	100	3
MGS-155	Economic Geology and Mining Geology	3	4	30	70	100	3
MGP-156	Petrology (Lab, Hard core)	8	4	30	70	100	4
MGP-157	Structural Geology, Hydrogeology and Basics of GIS (Lab, Hard core)	8	4	30	70	100	4
MGE-158	Geo-Sciences (Open Elective)	3	3	30	70	100	3
II Semester Total		36	27	240	560	800	28

III Semester - 2 Hard core (T), 1 Soft core (T), 1 Soft core (P), 2 Hard core (P) and 1 Open Elective (E)							
MGH-201	Oceanography-I (Physical and Chemical)	4	3	30	70	100	4
MGH-202	Oceanography-II (Geological and Biological)	4	3	30	70	100	4
MGS-203	Exploration, Engineering and Environmental Geology	3	3	30	70	100	3
MGP-204	Applications of geoinformatics in geosciences (Lab, Soft core)	6	3	30	70	100	3
MGP-205	Physical and Chemical Oceanography (Lab, Hard core)	8	3	30	70	100	4
MGP-206	Geological Field Work and Field Report (Lab, Hard core)	8	4	30	70	100	4
MGE-207	Ocean and Atmospheric Science (Open Elective)	3	4	30	70	100	3
III Semester Total		36	23	210	490	700	25
IV Semester							
MGP-251	Dissertation and Viva-Voce	32	-	100	300	400	16
				Dissertation=200 Viva-Voce=100			
IV Semester Total		32	-	100	300	400	16
Grand Total						2500	90
Note: MG -Marine Geology, H -Hardcore, S -Softcore, P -Practical/Project Work, and E -elective							

Course/Credit Pattern:

Semester Credits	Theory Hard Core (H)	Theory Soft Core (S)	Elective (E)	Practical/Project Work (P)	Total Credits
I - 2 Hard core (T), 2 Soft core (T), 1 Hard core (P) and 1 Soft core (P)	2 x 4= 8	2 x 3= 6	--	4(H), 3(S)	21
II - 2 Hard core (T), 3 Soft core (T), 2 Soft core (P) and 1 Open Elective	2 x 4= 8	3 x 3= 9	3	8(H)	28
III - 2 Hard core (T), 1 Soft core (T), 1 Soft core (P), 2 Hard core (P) and 1 Open Elective (E)	2 x 4= 8	1 x 3= 3	3	3(S), 8(H)	25
IV - Project work	--	--	--	16 (H)	16
Total	24	18	6*	36 (H)+6 (S)	90

Total Credits from all the Four Semesters = 21+28+25+16 = 90

Total Hard Core Credits = 6x4 = 24(T) + 5x4 = 20(P) +16(Project) = 60 = 67%

Total Soft Core Credits = 6x3 = 18(T) +2x3 = 6(P) +2x3 = 6(E) = 30 = 33%

FIRST SEMESTER

MGH 101: MINERALOGY AND GEOCHEMISTRY

This Course will enable students to:

CO1: Understand the fundamentals of crystallography and mineral properties.

CO2: Apply optical mineralogy techniques for mineral identification.

CO3: Classify and characterize major rock-forming minerals.

CO4: Understand the fundamental principles of geochemistry and cosmochemistry.

CO5: Apply principles of biogeochemistry, isotope geochemistry, and geochronology.

Skills, employability and entrepreneurship: This subject is a good opportunity for students not only to know about the formation of minerals from elements, useful to identify in the field. Students who exit with course have skills to work in quarrying, mining, rock polishing, cement, silica/glass, sand mining, brick, ceramic, pottery and refractory industries. They will be exposed to start their own entrepreneurship. Students are encouraged to undergo internships after the regular offline classes as well as during the vacation.

MINERALOGY		52 hrs
Unit 1	Introduction to crystallography: Crystal systems and elements of symmetry. 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. Behavior 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 minerals of the following groups; Olivine, Pyroxene, Amphibole, Garnet, Mica, Feldspar, Quartz, Aluminosilicate, Zeolites, Clay minerals. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	10 hrs
GEOCHEMISTRY		
Unit 5	Introduction to geochemistry and cosmo-chemistry: origin of elements and their abundance in the Universe. Structure and atomic properties of elements, periodic table. Chemical and geochemical classification of elements.	6 hrs
Unit 6	Composition of planets and the Earth's interior. Earth and its environment-lithosphere, hydrosphere and atmosphere. Meteorites and their applications. Distribution of elements in igneous, sedimentary and metamorphic rocks. Aerosols their composition, classification and importance. Geochemical aspects of soils.	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, principles in determining	8 hrs

	ages of rocks, sediments, and applications in different fields of the earth science including paleoclimate. Principles of geochemical analysis and sampling methods: water, sediments, soil, and dust. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	
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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. Hand Book of Geochemistry – Goldchmidt, V. M. (1958).
11. Geochemistry – Hammer Fmiza (2008).

Free online books

12. Fundamentals of Geochemistry, W. M. White <http://www.soest.hawaii.edu/krubin/GG325/textbook/>
13. Geochemistry Earth's System Processes Dionisios Panagiotaras Online | 512 Pages
14. Geochemistry Lecture Notes by Glen S. Mattioli and Ralph K. Davis
15. Geochemistry Lecture Notes W. M. Whit
16. Trace Element Geochemistry, Frederick Frey

MGH 102: STRATIGRAPHY AND PALAEONTOLOGY

This Course will enable students to:

CO1: Understand the fundamental principles and classifications of stratigraphy.

CO2: Analyze the stratigraphic evolution and key geological features of India.

CO3: Understand the fundamental concepts of palaeontology and fossilization.

CO4: Classify and interpret major invertebrate, vertebrate, and plant fossil groups.

Skills, employability and entrepreneurship: This subject is a good opportunity for students to study evolution of life as well the history of the earth. Students exit from this course, especially from the biological discipline have scope to work on many unsolvable problems which are directly related to the evolution of human beings. Similarly they have chance to work in fossil fuel exploration (coal and petroleum).

STRATIGRAPHY		52 hrs
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 Gondwana, Deccan Traps, Indo-Gangetic Plain and Himalaya.	8 hrs
Unit 4	Boundary problem and its significance in stratigraphy with emphasis on the Cretaceous - Tertiary (KT) boundary. Importance of Cenozoic Era with reference to evolution of climate and life. Quaternary period: Glacial and interglacial epochs. Sea-level fluctuations, causes and consequences. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	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 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.	4 hrs
Unit 8	Micropalaeontology: Extraction of microfossils from sediments. Microfossil groups: Foraminifera, Ostracoda, Radiolaria, Diatoms, Nannoplankton and Dinoflagellates. Applications of microfossils and trace fossils in Earth Sciences with special reference to hydrocarbon exploration. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	8 hrs

List of References

- 1) Stratigraphic Principles and Practice - M .J. Weller (1960).
- 2) Fundamentals of Historical Geology and Stratigraphy 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 and 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 and 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.

MGS 103: GEOMORPHOLOGY AND GEODYNAMICS

Students will learn to:

CO1: Understand the fundamental concepts and processes shaping Earth's surface.

CO2: Apply geomorphological principles to real-world scenarios.

CO3: Understand fundamental concepts of Earth's dynamic processes.

CO4: Analyze the theories of continental drift and plate tectonics.

Skills, employability and entrepreneurship: This subject is a good opportunity for students not only to know about the formation of continents and the oceans, as well as shape the earth surface features. This is useful to identify sites for tourism, urban development, mitigating geo-hazards and exploration of water, mineral and fossil fuel resources.

GEOMORPHOLOGY		42 hrs
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, epeirogenic and orogenic, climatic and tectonic factors and rejuvenation of landforms. Dynamics of geomorphology; geomorphic processes and resulting landforms.	8 hrs
Unit 2	Concepts of gradation, 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 and groundwater prospecting. Geomorphology of India with special reference to Karnataka. Martian and Lunar morphology. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	8 hrs
GEODYNAMICS		
Unit 4	Introduction to geodynamics. Seismic zones of India. Paleomagnetism: Polar wandering curve and magnetic reversals.	6 hrs
Unit 5	Continental Drift: Concept and different lines of evidences. The concept of the Super continent - Gondwanaland and its fragments.	6 hrs
Unit 6	Plate Tectonics: Concept of plate tectonics. Major and minor plates. Mechanism of plate motion, mantle convection. Rift Valleys. Vertical tectonics, concept of isostasy.	8 hrs

	Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	
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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 and Gupta (2001).
9. The Evolving Continents - Brain F. Windley (1977), John Wiley and Sons. 385p.
10. The Geology of Continental Margins - Springer Verlag, NY - Burk C. A. and 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. Prospecting: A manual for Geologist E.B.D. Educational Pvt. Ltd. Dehra Dun. 403p.
14. Parasnis, D. S. (1979). Principles of applied Geophysics. Chapman and Hall, - 275p.
15. Dobrin, M.B. (1976). Introduction to Geophysical Prospecting. New York McGraw-Hill, 630p.
16. Geodynamics Elsevier - Artyushkov E.V. (1983)

MGS 104: REMOTE SENSING AND PHOTOGRAMMETRY

This Course will enable students to:

CO1: Understand the fundamental principles of remote sensing and data acquisition.

CO2: Apply knowledge of various remote sensing platforms, sensors, and applications.

CO3: Understand the fundamentals of aerial photography and photogrammetry.

CO4: Apply aerial photo interpretation techniques in various Earth science contexts.

Skills, employability and entrepreneurship: These are advanced as well applied subjects in terms of studying the entire earth by using the computer and allied systems by making use of huge data collected from artificial satellites launched to the space and aircrafts. Data collected by the satellites are useful to monitor the entire world at different spatio-temporal scales. There is good scope of this subject in terms of employability in different organizations and MNCs. Students can start their entrepreneurship.

REMOTE SENSING		42 hrs
Unit 1	Fundamentals of Remote Sensing: History, basic concepts: Data acquisition and data analysis. Electromagnetic spectrum, spectral bands, Energy interactions in the atmosphere, energy interactions with the earth's surface features, spectral reflectance curves of various natural earth surface features like vegetation, soil and water	6 hrs

Unit 2	Earth Resource Satellites: Introduction, types of platforms, sensors and resolutions. POES and GOES series of satellites. Important earth observation satellites like Landsat, SPOT, NOAA, SEASAT, IKONOS, Quick bird, Orb view etc. Indian Remote sensing programs: IRS satellite missions and their capabilities, INSAT series. Advantages of satellite remote sensing.	8 hrs
Unit 3	Principles of Optical Remote Sensing: Introduction and concept of Visible remote sensing and Infrared remote sensing. Principles of Thermal and Microwave Remote Sensing: Introduction, Black body radiation, applications of thermal remote sensing. Basic concepts of microwave remote sensing, Microwave sensors: Real Aperture Radars and Synthetic Aperture Radars, applications of Microwave Remote Sensing. Light Detection and Ranging (LIDAR) and its applications.	10 hrs
Unit 4	Remote Sensing Applications: In Earth Sciences – Geological interpretation and structural mapping, geo-hydrological mapping and engineering projects, geomorphologic mapping, geo-environmental studies, mineral exploration, land use/land cover classification. In Oceanography– monitoring sea surface temperature and shoreline change detection studies. In weather forecasting, meteorological and climatic studies, such as cloud drift, precipitation, temperature, tropical cyclone. Drone survey and its applications.	10 hrs
	PHOTOGRAMMETRY	
Unit 5	Fundamentals of aerial photography and photogrammetry: History, aerial cameras, aerial films and processing, types of aerial photographs, scale, types of mosaics, and image displacement. Concepts of stereo- photogrammetry: normal vision, depth perception and vertical exaggeration. Elements of aerial photo interpretation. Digital photogrammetry.	4 hrs
Unit 6	Principles and applications of aerial photography: Aerial photo interpretation in resource evaluation and natural hazards. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	4 hrs

List of References

- 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 and Sons
- 6) Remote Sensing – Sabins, John Wiley and Sons
- 7) Manual of Remote Sensing - American Society of Photogrammetry
- 8) Manual of Photo Interpretation – American Society of Photogrammetry.
- 9) Fundamentals of Photogeology, Geomorphology – Verstappen – TTC Holland.

- 10) Applied Remote Sensing and Photo Interpretation – T. S. Chouhan and K. N. Joshi – Vignan Prakasan, Jaipur.
- 11) Photo geology and Image Interpretation – Shiv N. Pandey – Wiley Eastern, New Delhi.
- 12) Principles of Map Design: Tyner Judith A. - The Guil Ford Press.
- 13) Remote Sensing in Geomorphology: S.M. Ramaswamy- New India.

MGP 105: MINERALOGY AND PALAEONTOLOGY (Lab, Hard core)

This Course will enable students to:

CO1: Conduct comprehensive mineralogical analysis.

CO2: Identify and characterize diverse fossil types.

CO3: Apply palaeontological principles for chronological and evolutionary studies.

CO4: Utilize laboratory techniques for sample analysis and identification.

Skills, employability and entrepreneurship: This practical subject is very useful for transforming the knowledge from four walls to the field as Earth Science is a field of Science. Therefore, practical's of this subject are very relevant for students to enhance skills to work in quarry, mines, rock polishing, cement, silica/glass, sand mining, brick, ceramic, pottery and refractory industries. Similarly, students who pay attention to paleontology subject can become a paleontologist. They will be exposed to start their own entrepreneurship related to geo-hazards mitigation and fossil collection.

MINERALOGY (Lab)
1. Megascopic study of important rock forming minerals. 2. Microscopic study of important rock forming minerals. 3. Crystallography: Crystal systems and angular relationships. 4. Calculation of mineral formula from chemical data of olivine, garnet, pyroxene and amphibole. 5. Identification of mineral samples collected by students during the field work. 6. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.
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. 8. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.

MGP 106: REMOTE SENSING AND GEO-STATISTICS (Lab, Soft core)

This Course will enable students to:

CO1: Perform fundamental remote sensing image analysis techniques.

CO2: Execute advanced digital image processing operations.

CO3: Apply core statistical measures and analyses to geological data.

CO4: Utilize specialized software for geostatistical analysis and data visualization.

Skills, employability, and entrepreneurship: These courses are useful for students to study aerial photographs and the interpretation of satellite images, numerical problems on aerial photographs and satellite images, and image classifications. Geostatistics provides a powerful set of tools for analyzing and understanding spatial data, considering the unique characteristics of location and its impact on data relationships. Students who learn the fundamental concepts of remote sensing and Geostatistics have good opportunities, as well they can also start their entrepreneurship.

REMOTE SENSING (Lab)	
1.	Satellite image interpretation: Visual interpretation of Black and White and FCC images.
2.	Numerical problems on aerial photographs.
3.	Plotting of spectral reflectance curves for vegetation, soil, and water.
4.	Georeferencing – image rectification based on a coordinate system.
5.	Mosaic of satellite images.
6.	Digital Image Processing: Importing and exporting, image enhancement techniques.
7.	Classification of satellite images: supervised and unsupervised classification methods.
8.	Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.
GEO-STATISTICS (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 using graphs and diagrams.
7.	Computer aided design and graphics.
8.	Programming languages and operating systems. Flow chart, Algorithm.
9.	Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.

SECOND SEMESTER

MGH 151: PETROLOGY

This Course will enable students to:

CO1: Comprehend the generation and evolution of magmas.

CO2: Classify and identify igneous rocks. Students will learn to recognize and describe the forms, structures, and textures of igneous rocks, and apply standard classification systems

CO3: Understand the formation and characteristics of sedimentary rocks.

CO4: Classify and identify major sedimentary rock types.

CO5: Explain metamorphic processes and rock characteristics.

Skills, employability and entrepreneurship: Like the first subject, this one is a good opportunity for students especially about the formation of rocks which are useful to identify the better quality material in the field for the major constructions/civil engineering projects as well as dimensional and decorative stones. Students exit with course have skills to work in industries related to earth resources, agricultural and soil survey and public works. They will be exposed to start their own entrepreneurship.

IGNEOUS PETROLOGY		52 hrs
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. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	6 hrs
SEDIMENTARY PETROLOGY		
Unit 4	Sources and formation of sediments. Textures and structures of sedimentary rocks.	6 hrs
Unit 5	Diagenesis and lithification. Classification of sediments: Udden-Wentworth classification. Classification of sedimentary rocks: based on origin, grain size – rudaceous, arenaceous and argillaceous.	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	Introduction: Metamorphism, 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, facies of metamorphism. Origin and occurrence of gneiss, granulites, quartzites, schists, slates and marbles. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	6 hrs
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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 152: STRUCTURAL GEOLOGY AND HYDROGEOLOGY

This Course will enable students to:

CO1: Comprehend fundamental concepts of rock deformation.

CO2: Analyze and classify major geological structures.

CO3: Interpret unconformities and their significance.

CO4: Understand the principles of the hydrological cycle and groundwater occurrence.

CO5: Evaluate groundwater quality, management, and exploration methods.

Skills, employability and entrepreneurship: These subjects are good opportunity for students to learn not only to know the large-scale earth's features which favour water and mineral accumulations. Similarly, students who pay attention to this subject can become a hydrogeologist. They will be exposed to start their own entrepreneurship. Students are encouraged to undergo internships after the regular offline classes as well as during the vacation.

STRUCTURAL GEOLOGY		52 hrs
Unit 1	Introduction: Importance of structural 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. Concept of stereoprojection.	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. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	8 hrs
HYDROGEOLOGY		
Unit 5	Introduction: Origin of water, hydrological cycle and its components – precipitation, interception, runoff, evaporation and evapotranspiration; Groundwater: types, importance, occurrence, movement and vertical distribution of groundwater; 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.	8 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; hydro-stratigraphic units. Salt water intrusion in coastal and island aquifers; groundwater legislation in rural and urban areas.	8 hrs
Unit 7	Wells: types, drilling methods, construction, design, development and maintenance.	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. Basics of groundwater modeling. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	6 hrs

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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 and 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. Groundwater – C. F. Tolman – McGraw-Hill Book Co. Inc.
11. Groundwater Hydrology (2nd Ed.) – D. K. Todd, John Wiley and Sons Inc. New York
12. Groundwater Resources Evaluation - W.C. Walton - McGraw-Hill Book Co. New York
13. Ground Water Assessment, Development and Management – K. R. Karanath – Tata
14. Groundwater – H. M. Raghunath – Wiley Eastern Limited
15. Hydrology – H. M. Raghunath – Wiley Eastern Limited
16. Elements of Hydrology – V. P. Singh
17. Engineering Hydrology – K. Subramaniam – Tata McGraw Hill Publishing Co. Ltd.

MGS 153: GIS AND GPS

This Course will enable students to:

CO1: Understand the fundamental concepts of Geographic Information Systems and spatial data representation.

CO2: Apply spatial data models and quality control techniques

CO3: Execute various spatial analysis operations in a GIS environment

CO4: Utilize Digital Elevation Models and related terrain analysis techniques.

CO5: Evaluate the applications and limitations of GIS and Global Positioning Systems.

Skills, employability and entrepreneurship: This course paper is an advanced type in terms of not only studying the entire earth science in general, but also all aspects of spatio-temporal data of any discipline in particular. With the help of advanced GIS software, massive data collected over time can be analyzed to determine complex future trends. There is a good scope of this course for students who can work as geoinformaticians, GIS engineers in government organizations like ISRO, IIRS, KRSRAC, INCOIS etc., and in private institutions such as disaster management organizations and MNCs. Students can also open their own start-up companies.

GIS and GPS		42 hrs
Unit 1	Introduction: Data and information: Types of data - spatial and non-spatial. Geographical Information System: Introduction, Components of GIS. Database Management System (DBMS). Map Concept: map features, scale, resolution and accuracy. Map Projection: Earth's size and shape in time and space. Spherical coordinate system: Geographic coordinate system (GCS) – datum, geoid. Projected coordinate system (PCS) - Cylindrical, Conical and Azimuthal projections etc., UTM Coordinates.	8 hrs
Unit 2	Spatial Data Models: Raster and Vector models. Advantages and Disadvantages of Raster and Vector Models. Georeferencing, Digitization, topology creation and structuring of map data. Data quality and errors: Types of Errors and source of errors.	6 hrs
Unit 3	Spatial Analysis: Introduction, spatial analysis tools in GIS. Vector-based - overlay analysis operations: Topological overlays, Polygon-in-polygon overlay, line-in-polygon overlay, Point-in-polygon overlay, Logical operations (Boolean operations), Buffer analysis. Raster-based analysis operations: Grid-based spatial analysis. Grid operations used in map algebra, Advantages and disadvantages of raster analysis.	10 hrs

Unit 4	Digital Elevation and Terrain Models (DEM and DTM): Generation and structure of DEM/DTM and their applications. Geospatial Triangulated Irregular Network (TIN) model.	4 hrs
Unit 5	Applications of GIS: Application of GIS in Natural Disaster Management studies, water resources/hydrology, coastal zone morphology and management, environment and forest studies, atmosphere, and other fields. Open source data: USGS, Bhuvan, Bhukosh, Google Earth, etc. Limitations of GIS.	8 hrs
Unit 6	Global Positioning System (GPS): Introduction to GNSS, GPS and its segments, GPS satellites and receivers. GPS-Error sources, measurements, accuracy and estimates of user position and time. Application and limitations of GPS. IRNSS. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	6 hrs

List of References

- 1) Geographical Information System: A Guide to Technology – John C. Antenucci – Van Norstrand Reinhold Publications
- 2) Principles of Geographical Information System for Land Resource Assessment – P. A. Burrough – Oxford University Press
- 3) Computers: Concepts and Uses – Mary Summer - Prentice Hall
- 4) Computer Fundamentals - P K Sinha BPB
- 5) Manual of Photo Interpretation – American Society of Photogrammetry
- 6) Photogeology and Image Interpretation – Shiv N. Pandey – Wiley Eastern, New Delhi
- 7) Fundamentals of Photogeology, Geomorphology – Verstappen – TTC Holland.
- 8) Elements of GPS: Nand Kishore Agrawal.
- 9) Geographic Information Analysis: Darid O, Sur - John Willey.
- 10) A Primer of GIS: Fundamental Geographic and Cartographic concept: Francis Harvey - Rawath Publisher.
- 11) Geoinformatics: G. Randy Keller and Chaithanya Bara - CUP
- 12) Remote Sensing in Geomorphology: Patrick Simon-Oxford Book Company.
- 13) Remote Sensing Techniques for Regional Development: Banarjee R. K- Concept Publishers.

MGS 154: METEOROLOGY AND CLIMATOLOGY

This Course will enable students to:

CO1: Understand the fundamental elements and structure of the atmosphere.

CO2: Analyze global and regional weather patterns, with a focus on monsoons.

CO3: Evaluate meteorological hazards and their monitoring.

CO4: Differentiate between meteorology and climatology and explain causes of climate variation.

CO5: Interpret past climate records and understand climate classification schemes.

Skills, employability and entrepreneurship: These subjects are mainly the basis for the MSc/M.Tech in Meteorology, climatology. The main purpose of introducing these subjects are to bring to the notice of students about the weather/climate change, their extreme variability including the study of the past weather/climate. This provides the basis for predicting the future. Students with these skill can serve in different R and D labs. Research institutions and private organizations.

METEOROLOGY		42 hrs
Unit 1	Elements of meteorology and their significance. Structure of the atmosphere, classification clouds, precipitation and its types, temperature, atmospheric pressure, winds and humidity. 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, tropical cyclones. 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.	8 hrs
Unit 3	Weather monitoring, meteorological hazards and weather modification: Thunder storms, dust storms, cloud burst, cyclones and related processes, floods, drought and famine. 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. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	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 anthropogenic factors (changes in the concentration of greenhouse gases).	6 hrs
Unit 5	Climate system, 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 modeling. Milankovitch cycle.	6 hrs
Unit 6	Paleoclimatology: Principles of 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. Climate change and short-term and long terms climate cycle. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	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 and 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 155 - ECONOMIC GEOLOGY AND MINING GEOLOGY

This Course will enable students to:

CO1: Understand the principles of ore genesis and classification of mineral deposits.

CO2: Analyze the geology and economic significance of metallic and non-metallic mineral deposits.

CO3: Comprehend the geology and exploration of precious/semiprecious stones and hydrocarbons.

CO4: Describe the formation, types, and resources of coal.

CO5: Understand mining methods and the environmental aspects of mining.

Skills, employability and entrepreneurship: These are the most important subjects for the national development in terms of attaining sustainability of water and mineral resources. Similar to the above mentioned subjects with an emphasis on mining techniques are taught in this course. Students have chance to visit mining sites as well as ocean expedition related to ocean mining. Students exit with course have skills to work as exploration/mining geologists in organizations related to water resources, geological/ marine surveys, seismological stations and mining including the R & D labs. and educational institutions.

ECONOMIC GEOLOGY		42 hrs
Unit 1	Ore genesis. Classification of ore deposits – renewable and non-renewable, metallogenic epochs and provinces.	4 hrs
Unit 2	Metallic deposits: origin, occurrence, and geology of iron, manganese, copper, gold, aluminum 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 and shale gas.	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 (CBM). Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	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.	6 hrs
Unit 8	Underground mining methods - stopping and caving, coal and metallic mineral mining. Ventilation and mine supports. Impacts of mining and acid mine drainage. Environmental impact of mining and reclamation of mines. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	6 hrs

List of References

- 1) R N P Arogyaswamy: Curses in Mining Geology (1973)
- 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 and 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 and 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.

MGP 156: PETROLOGY (Lab, Hard Core)

This Course will enable students to:

CO1: Identify and classify common rock types through megascopic and microscopic analysis.

CO2: Analyze and describe the structural, textural, and mineralogical features of rocks.

CO3: Apply laboratory and field observations for rock identification and characterization.

Skills, employability and entrepreneurship: Applications of this subject is similar to MGP 404 in the sense that this subject is essentially on petrology. Students can enhance their skills to work in quarrying, mining, rock polishing, cement, silica/glass, sand mining, brick, ceramic, pottery and refractory industries. They can start their entrepreneurship.

1. Identification of igneous, metamorphic and sedimentary rocks (hand specimen).
2. Study of mega structures, textures and mineralogy of igneous, metamorphic and sedimentary rocks.
3. Microscopic study of igneous, metamorphic and sedimentary rocks.
4. Identification of various rock samples collected by the students during the field work.
5. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.

MGP 157: STRUCTURAL GEOLOGY, HYDROGEOLOGY AND BASICS OF GIS (Lab, Hard core)

This Course will enable students to:

CO1: Apply field and graphical techniques for structural analysis.

CO2: Perform fundamental hydrogeological calculations and mapping.

CO3: Generate and interpret hydro-geomorphological and drainage features from maps.

CO4: Execute essential GIS data creation and manipulation operations.

CO5: Conduct spatial analysis and create advanced geospatial visualizations using GIS.

Skills, employability and entrepreneurship: These subjects are good for students to learn not only to know major structures of the earth, the large-scale earth's features which favor water and mineral accumulations. Also learn all aspects of spatio-temporal data of any discipline in particular with the help of advanced GIS software, massive data collected over time can be analyzed to determine complex future trends. Similarly, students who pay attention to this subject can become a good structural geologist, hydrogeologist and geoinformatician. They will be exposed to start their own entrepreneurship related to hydrogeology, GIS, geo-hazards mitigation etc.

STRUCTURAL GEOLOGY AND HYDROGEOLOGY (Lab – 2hrs)

1. Measurement of strike and dip by using compass clinometer/brunton compass in the field.
 2. Determination of thickness of strata by graphical and mathematical methods.
 3. Construction of the geological cross-sections to identify the order sequence of formation, pre/post igneous and structural events, and unconformities.
 4. Construction of contour maps and tracing the outcrops with geological interpretations.
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1. Preparation of isohyetal maps and calculation of depth of rainfall.
 2. Determination of aquifer parameters.
 3. Calculation of depth to saline and fresh water interface.
 4. Calculation of specific capacity of dug wells and bore wells.

5. Generation of hydro-geomorphological features from topographic maps.
6. Drainage network and morphometric parameters.
7. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.

BASICS OF GIS (Lab – 2hrs)

1. Georeferencing – image rectification based on a coordinate system using GIS software
2. Onscreen digitization – extraction of point, line, and polygon features.
3. Edge matching/ spatial adjustment.
4. Extraction of Thematic maps: preparation of thematic layers on screen from Toposheets, images - Settlement, Road, Drainage network, waterbody, wetland, etc.
5. Calculation of area, perimeter, and distance using GIS software.
6. Data integration – linking of spatial and non-spatial data.
7. Map composition and presentation of results.
8. Spatial analysis: clip, erase, split and merge and proximity analysis – buffer, multiple buffer.
9. Creation of 3D maps: Slope (degrees and percentages), Contour, TIN, Hillshade, Aspect with GIS software.

MGE 158: GEOSCIENCES (Open Elective)

This Course will enable students to:

CO1: Understand the fundamental composition, structure, and dynamic processes of the Earth.

CO2: Analyze Earth's surface features and geological structures.

CO3: Evaluate Earth's natural resources and geological hazards.

Skills, employability and entrepreneurship: This paper is useful to the sister departments of the Earth Science, such as chemistry, physics, life sciences, statistics, computer as well as computing sciences. Usually science students other than earth science qualify NET exams/interviews in the institutes join earth science related organizations. They learn earth science in their area of research. However, with the knowledge of this subject (earth science), students can perform better in their career thereby utilizing the intension of studying the interdisciplinary science. Students have employability in many branches of science in different government organizations and MNCs. Students can start their own entrepreneurship.

GEOSCIENCES		42 hrs
Unit 1	Introduction to geology, structure and composition of the Earth's interior: crust, mantle and core. 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	Geomorphology: weathering, erosion, transportation and deposition. Description of Earth surface features. Types of landforms, physiographic division of India.	8 hrs
Unit 4	Structural geology: Dip and strike, primary structures, secondary structures, geometry and classification of folds, faults and joints.	6 hrs
Unit 5	Natural Resources: Renewable and non-renewable resources. Soil, water, rocks and minerals. Origin, occurrence and distribution of oil and natural gas. Economically important metallic and non- metallic mineral deposits of India.	8 hrs

Unit 6	Geological hazards: Volcanoes, earthquake, landslide, cyclone, tsunami, saltwater intrusion, flood, drought and coastal erosion. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations in geological museum.	8 hrs
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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 Hilimer, G. (1983)
5. Micropalaeontology, Graham and Trotman - Bignot, G. (1985)
6. An introduction to Paleobotany - Arnold, Chester R
7. Field Geology – McGraw Hill Book Co. - Lahee, F.H. (1961)
8. Structural Geology – 3rd edition, Prentice Hall - Billings M.P. (1977)
9. Stratigraphy and Sedimentation, W.H. Freeman – Krumbein and Sloss (1963)
10. Economic Mineral Deposits – Bateman
11. India's Mineral Wealth - Oxford Univ. Press - Brown and Dey (1975)
12. Industrial Minerals and Rocks of India - Allied Publishers - Deb, S. (1987).
13. Hydrogeology – K. R. Karanth – Tata McGraw Hill Publishing Co. Ltd.
14. Groundwater – H. M. Raghunath – Wiley Eastern Limited
15. Elements of Hydrology – V. P. Singh
16. Courses in Mining Geology – R.N.P. Arogyaswamy, Oxford and IBH Publishing Co.

THIRD SEMESTER

Skills, employability and entrepreneurship: This semester is quite unique opportunity for students not only to know about the oceans as they cover 71% of the earth surface, but explore further living and non-living mineral resources, in the scenario of depletion of continental resources. Students have chance to go on ocean expedition and exit with course have skills to work in organizations related to ocean and well as Navy. They will be exposed to start their own entrepreneurship. Students are encouraged to undergo internships after the regular offline classes and attend the webinars related to the oceans.

MGH 201: OCEANOGRAPHY – I (PHYSICAL AND CHEMICAL)

The student will learn to:

CO1: Understand the dynamics of ocean waves, tides, and mixing processes.

CO2: Analyze coastal processes and their impact on marine environments.

CO3: Explain global ocean circulation patterns and their driving forces.

CO4: Investigate complex ocean-atmosphere interactions and estuarine dynamics.

CO5: Comprehend the chemical composition and biogeochemical cycling in the ocean.

Skills, employability and entrepreneurship: These are similar to the above mentioned ones with an emphasis on the physics and chemistry of the oceans. Students have chance to go on ocean expedition and exit with course have skills to work in organizations related to ocean and well as Navy including the R & D Labs and educational institutions.

PHYSICAL OCEANOGRAPHY		52 hrs
Unit 1	Wind generated waves in the oceans; and their characteristics; shallow and deep-water waves. Wave propagation, refraction, reflection and diffraction of waves. Wave spectrum, and principles of wave forecasting. Mixing processes in the oceans; characteristics of major water masses. Tide-producing forces and their magnitudes; prediction of tides using the harmonic method; tides and tidal currents in shallow seas and estuaries. Introduction to hydrographical charts.	6 hrs
Unit 2	Factors influencing coastal processes; transformation of waves in shallow water; effects of stratification; and bottom friction, littoral currents; wave action on sediment movement; rip currents; beach stability, ocean beach nourishment; harbor resonance; seiches; tsunami; interaction of waves with structures.	6 hrs
Unit 3	The global wind system; wind action on ocean the surface; Ekman's theory; Sverdrup, Stommel and Munk's theories; upwelling and sinking with special reference to the Indian ocean. Inertial currents; zones of divergence and convergences; geostrophic motion; barotropic and baroclinic conditions; oceanic eddies, relationship between density, pressure and dynamic topography; relative and slope currents. Study of major surface current patterns in the Indian ocean, Atlantic ocean and Pacific ocean.	6 hrs
Unit 4	Wind driven coastal currents; typical scales of motion in the ocean. Characteristics and causes of the global conveyor belt circulation. Formation of subtropical gyres; western boundary currents; equatorial current systems; El Niño and La Niña phenomena; monsoonal winds and associated currents in the North Indian Ocean; the Somali current; Upwelling in the Arabian Sea. Estuaries: classification and nomenclature; estuarine circulation and mixing; depth-averaged and breadth-averaged models; sedimentation; salinity intrusion in estuaries; effects of stratification; coastal pollution; mixing and dispersal of pollutants in estuaries and nearshore areas. Consequences of ice movement.	8 hrs

CHEMICAL OCEANOGRAPHY		
Unit 5	Introduction to chemical oceanography: principles and processes regulating the composition of seawater – primary and secondary inputs from rivers, the atmosphere, hydrothermal vents and diagenetic processes.	6 hrs
Unit 6	Constancy of the ionic composition of seawater. Classification of elements based on their distribution; major and minor constituents; behavior of elements; chemical exchanges across river-sea, particulate-dissolved phases and sediment-water interfaces.	6 hrs
Unit 7	Distribution of radionuclides and dissolved gases in the oceans for understanding water column dynamics and scavenging by sedimentary particles. Residence times of elements in seawater and the processes regulating them.	6 hrs
Unit 8	Chemical and biological interactions – ionic interactions; cycling and air- sea exchange of biogenic dissolved gases; the carbon dioxide- carbonate system; alkalinity and control of pH; regulation. Abiotic and biotic controls of trace elements in the ocean; the biological pump and role in regulating the atmospheric composition. Ocean acidification and anthropogenic impacts on ocean chemistry. Ocean water sampling methods and advanced analytical technologies. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	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. Emerson, E and Hedges, J. (2008) Chemical Oceanography and the Marine Carbon Cycle. Cambridge University Press.
5. Riley, J. P. and Chester, R. 1971. Introduction to Marine Chemistry, Academic Press,
6. Chemical Oceanography, Vol. 1- 10 (2nd Ed.) - J. P. Riley and G. Skirrow, eds, Academic Press (1975–1989).
7. Fasham, Michael J.R. (2003) Ocean Biogeochemistry. The Role of the Ocean Carbon Cycle in Global Change Series.
8. Komar, P. D., (1976) Beach Processes and Sedimentation, Prentice-Hall. 429p.
9. Reddy M.P.M. (2001) Descriptive Physical Oceanography, A A 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.
12. Schulz, H.D. and Zabel, M. (2006) Marine Geochemistry. Springer. 221p.
13. Coastal Engineering Processes: Dominic Reeve, Andrew Chadwick and Chris Fleming - Allied Publishers
14. Marines on the Beach: Christopher Paul - Allied Publishers. .
15. The Indian Ocean Tsunami: Karon Pradhyumna and Subbiah Shanmugham- Foundation.
16. Coastal Zone Management: United Nations Convention on Law of the Sea-Unclos III: Ar.Dushyant Kamat - Jnanadha Prakash.
17. Coastal Hydrodynamics: J. S. Mani - PHI Learning Pvt Ltd.
18. Ocean Energy: R. H. Charlies and C. W. Finkl - Springer.

19. Coastal and Marine: Geospatial Tech David R. Green – Springer.
20. Glossary of Geoscience and Oceanography: Tanmaya Rudra - Jnanadha Prakashana.
21. Understanding Sea Level Rise and Variability: Church John A. - John Velly and sons.

MGH 202: OCEANOGRAPHY – II (GEOLOGICAL AND BIOLOGICAL)

This Course will enable students to:

- CO1: Describe the morphology and tectonic evolution of ocean basins and coastal features.
 CO2: Analyze marine sedimentation, paleoenvironmental reconstructions, and coastal management.
 CO3: Evaluate marine energy and mineral resources.
 CO4: Understand the Law of the Sea Treaty and maritime zones.
 CO5: Comprehend the factors influencing marine life and major marine ecosystems.

Skills, employability and entrepreneurship: These are similar to the above mentioned ones with an emphasis on the geological and biological processes taking place in the oceans, and their exploration. Students have chance to go on ocean expedition and exit with course have skills to work in organizations related to ocean and well as Navy including the R & D Labs. and educational institutions.

	GEOLOGICAL OCEANOGRAPHY	52 hrs
Unit 1	Introduction to geological Oceanography. Classification of coasts: Valentin's coastal classification. Description of coastal features: beaches and palaeobeaches, sea stacks, sea stump, sea caves and notches. Ocean floor morphology. Description of continental shelf, continental slope, continental rise and abyssal plains, mid-oceanic ridge, subduction zones, trenches, ocean basins, island arcs, hot spots, and oceanic plate boundaries.	8 hrs
Unit 2	Factors controlling the deposition and distribution of marine sediments - biogenous, cosmogenous, hydrogenous, terrigenous and authigenic sediments. Tectonic evolution of the ocean basins. Reconstruction of monsoon variability using marine proxy records. Opening and closing of ocean gateways and their effect on ocean circulation and climate during the Cenozoic era. Sea-level changes and methods to determine paleo-sea surface temperatures with special reference to Quaternary and Holocene climate. Coastal Regulation Zones (CRZ): Concept of coastal Regulation Zones. Classification of Zones, Criteria of Zonation and Evolution of CRZ norms.	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; with emphasis on the Indian scenario; Wave energy-potential and utilization. Ocean Thermal Energy Conversion (OTEC)- principle, factors affecting OTEC and special features. Working principles of various ocean energy systems.	4 hrs
Unit 4	Definition, characteristics, marine geological setting, genesis and occurrence. Metalliferous sediments, phosphorites (mineralogy and geochemical characteristics and depositional environments). Importance of marine mineral resources: biotic and abiotic resources. Polymetallic nodules, Cobalt crusts, Hydrothermal sulfide deposits including black and white smokers. Placers: placer minerals, classification and environments of placer mineral deposition (rivers, beaches and offshore areas). Sand as a resource. Ocean floor sampling – types, instruments and techniques.	10 hrs

Unit 5	Law of the Sea Treaty: and historical background. United Nations Convention on the Law of the Sea (UNCLOS) I, II and III– demarcation of maritime zones :Territorial Sea, Contiguous Zone, Exclusive Economic Zone (EEZ), legal continental shelf, high seas, and the international area of the seabed). Rights and responsibilities of coastal nations. Role and functions of International Seabed Authority. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	4 hrs
	BIOLOGICAL OCEANOGRAPHY	
Unit 6	Introduction: Physico-chemical factors affecting marine life – light, temperature, salinity, pressure, nutrients, dissolved gases; adaptation and biological processes of marine organisms. Diversity index and its applications in biological oceanography. Marine food-web dynamics. Characteristics of Case-I and Case-II waters. Human impacts on marine communities; including the effects 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; controlling factors affecting phytoplankton and zooplankton abundance and its diversity. Plankton and harmful algal blooms (HABs). Nekton and introduction to fishery oceanography. Benthic organism, coral reefs, foraminifera, diatoms, ostracods and dinoflagellates. Coastal- marine communities and benthic ecology. Overview of marine eco systems: estuaries, coral reefs, mangroves, deep-sea environment including hydrothermal vent communities.	6 hrs
Unit 8	Outline of microbenthos, meiobenthos and macrobenthos in the ocean. Chlorophyll distribution in oceans and its significance. Instrumentation and techniques: Secchi disc, dissolved oxygen (DO) meter, Salinometer, and multiparametric ocean probes to measure salinity, temperature, chlorophyll, and dissolved oxygen. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	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).
- 7) Carol M. Lalli and Timothy R. Parsons (1997) Biological Oceanography: An Introduction.
- 8) Miller, C.B. (2004) Biological Oceanography. Blackwell Publishers. 416pp.

- 9) George Karleskint, Richard Turner, James Small, (2012) Introduction to Marine Biology
Publisher: Brooks Cole, 512 p.

MGS 203: EXPLORATION, ENGINEERING GEOLOGY AND ENVIRONMENTAL GEOLOGY

This Course will enable students to:

- CO1: Understand the principles and methods of geological exploration for mineral deposits.
CO2: Apply geophysical techniques for onshore and offshore exploration.
CO3: Evaluate geological factors influencing civil engineering projects.
CO4: Analyze environmental issues related to Earth's lithosphere, hydrosphere, and atmosphere.
CO5: Assess geological hazards and their management strategies.

Skills, employability and entrepreneurship: These are similar to the above mentioned subjects with an emphasis on exploration techniques of earth resources, processes taking place in the oceans, and their exploration as well as the environmental issues related to the exploration and engineering techniques. Students have chance to go on geological field work, visiting mining sites as well as ocean expedition. Students exit with course have skills to work as an exploration/mining geologists in organizations related to water resources, geological/ marine surveys, seismological stations and mining including the R & D labs. and educational institutions.

EXPLORATION GEOLOGY		42 hrs
Unit 1	Introduction: scope and objectives of exploration geology. Geological exploration/prospecting: various geological criteria for the identification of mineral deposits (path finders). Different techniques and methods of geological prospecting/exploration.	6 hrs
Unit 2	Geophysical exploration: methodology and applications of onshore and offshore geophysical explorations - gravity, magnetic, seismic, electrical and radioactive techniques. Echosounder and its uses. Well logging techniques. Geochemical and bio-geobotanical methods exploration: Geochemical and biogeochemical indicators of economically important ore deposits. Geobotanical prospecting: importance of plants in identifying the ore deposits.	8 hrs
ENGINEERING GEOLOGY		
Unit 3	Engineering properties of rocks. Physical characteristics of building materials. Geological aspects in planning, design and construction of major civil structures.	4 hrs
Unit 4	Geological investigations for dams, reservoirs and spillways, bridges, highways and tunnels. Problems of groundwater in engineering projects and remedial measures. Environmental considerations related to civil engineering and mining projects.	8 hrs
ENVIRONMENTAL GEOLOGY		
Unit 5	Lithosphere: Constituents of Earth's material. Soil profile, soil erosion - causes and effects, silting of estuaries and reservoirs, soil conservation measures. Types of water pollution: surface, groundwater and marine water. Atmospheric pollution – acid rain, global warming, greenhouse effect, urban heat islands and heat wave.	8 hrs

Unit 6	Geological hazards: Earthquake, volcanic eruption, landslide, droughts, floods, tsunami - their significance, causes, preparedness and mitigation. Seismic zones of India. Coastal erosion, CRZ Act and coastal zone management. Environmental impact assessment (EIA). Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	8 hrs
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List of References

1. Condie, K.C. Plate tectonics and Crustal Evolution, Pergamon Press, 288p. (1989)
2. Vine, F. J., and Matthews, P. M. (1963). Magnetic anomalies over ocean ridges. Nature, 199, 947-949.
3. Bott, M.H.P., (1971). The Interior of the Earth. Arnold, London, 316p.
4. Khan, M. A., (1975). The Afro-Arabian Rift System. Sci. Prog. 62, 207-236.
5. McElhinny, (1973). Palaeomagnetism and Plate Tectonics. Cambridge Univ. Press, 358p.
6. Ramachandra Rao, M. B (1975). Outlines of Geophysical Prospecting: A manual for Geologist E.B.D. Educational Pvt. Ltd., Dehra Dun. 403p.
7. Parasnis, D. S. (1979). Principles of applied Geophysics. Chapman and Hall, - 275 p.
8. Dobrin, M.B. (1976). Introduction to Geophysical Prospecting. New York McGraw-Hill, 630p.
9. Physical Geology – Foster Robert, J. (1975).
10. Ecology, Environment and Pollution - A. Balasubramaian (1995) M/s Indira Publishers, Mysore.
11. Atmosphere, Weather and Climate: An introduction to Meteorology – Narora, S. B. Saunders Co., Philadelphia.
12. Physical Geology - A. N. Strahler
13. R.W. Tank: Focus on Environmental Geology (p.256)
14. Disaster Management: Dr. Ranita Nagar - APH publishers.
15. Disaster Management: 3 Volumes set - APH publishers.
16. Management of Natural and Man-made Disasters: Aradhana Salpekar - Jnanadha Prakashana.

MGP 204: APPLICATIONS OF GEOINFORMATICS IN GEOSCIENCES

(Lab, Soft Core)

This Course will enable students to:

CO1: Produce thematic maps for geological and environmental features using remote sensing and GIS techniques.

CO2: Perform advanced spatial analysis for hydrological and environmental modeling.

CO3: Apply geospatial techniques for hazard, resource, and oceanographic mapping.

Skills, employability and entrepreneurship: These subjects are practical experiences of the advanced subjects and details are provided in the MGS 453: GIS and GPS. Students have employability in different organizations related to human resource development as well as private firms and MNCs. Students can start their own entrepreneurship.

1. Extraction of thematic maps: geomorphology, lithology, soil, lineament etc.
2. Preparation of LULC map: Supervised and unsupervised classification methods.
3. Watershed boundary delineation from DEM– creation of flow direction, flow length, flow accumulation, and watershed boundary.
4. Spatial distribution map of water quality parameters: pH, Hardness, EC, turbidity, etc., by interpolation method
5. Oceanography: Construction of Chlorophyll-a, Sea Surface Temperature (SST), Depth, Salinity, Biomass, and Total Suspended matter, using the inverse distance weighted (IDW) method.
6. Rainfall mapping: Interpretation, generation of Thiessen polygon, Precipitation contours.
7. Generation of geohazards susceptible zone mapping (landslide, flood, drought, soil erosion), groundwater potential zone mapping (GWPZ) and potential fishing zone mapping by weighted overlay analysis.
8. GPS and total station survey and mapping.
9. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.

MGP 205: PHYSICAL AND CHEMICAL OCEANOGRAPHY

(Lab, Hard Core)

This Course will enable students to:

CO1: Analyze and interpret physical oceanographic data and coastal processes.

CO2: Perform fundamental chemical analyses of water and sediment samples.

CO3: Apply principles of geochemical analysis and proper sampling techniques in oceanography.

Skills, employability and entrepreneurship: These are similar to the above mentioned ones (MGH 201) with an emphasis on the practical related to the physical oceanography and land survey. Students have chance to go on ocean expedition and exit with course have skills to work in organizations related to National Institute of Oceanography and sister departments, research institutes, Navy, geological survey, mining and ocean related R & D Labs, and educational institutions.

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 and CSS diagram and study of waves. 5. Preparation and study of tidal curves (mean tidal range, spring and neap tidal range - for different months). 6. Calculation of velocity of sound using Nomograph. 7. Identification of beach characteristics, beach profiling, littoral drift study, wave periodicity and current problems of coastal erosion and impacts. 8. Sediment sample collection and grain size analysis. 9. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.
CHEMICAL OCEANOGRAPHY (Lab)
1. Introduction to principles of geochemical analyses. 2. Determination of physico-chemical parameters – pH, salinity, TDS, chlorosity, hardness, calcium and magnesium. 3. Estimation of dissolved oxygen in water samples with its importance in aquatic, marine and terrestrial environments. 4. Estimation of partial pressure of carbon dioxide in water samples. 5. Water sample collections, preservation methods and geochemical analysis of samples collected by students. 6. Determination of moisture content, porosity, and density of sediment samples collected by the students. 7. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.

MGP 206: Geological Field Work and Field Report (Lab - Hard core)

This Course will enable students to:

CO1: Execute independent and collaborative geological fieldwork or participate in oceanographic expeditions.

CO2: Apply observational and analytical skills in a real-world geological or oceanographic setting.

CO3: Produce a comprehensive and scientifically sound geological/oceanographic field report.

Skills, employability and entrepreneurship: it is completely devoted to geological field work, sample collection and visit to various national organizations and sister departments, research institutes, geological survey of India, mining and ocean related R & D Labs, and educational institutions.

Field Work: All students must do detailed geological field work/participate in the ocean expedition/visit to various organizations under the guidance of faculty members. The faculty members will continuously evaluate the performance of the students during field work/ocean expedition.

Field Report: A detailed report must be submitted immediately after the field work/ocean expedition. The report will be evaluated.

MGE 207: OCEAN AND ATMOSPHERIC SCIENCE (Open Elective)

This Course will enable students to:

CO1: Comprehend the fundamental physical and chemical properties of the ocean.

CO2: Analyze the interplay of biological and geological processes within the ocean.

CO3: Evaluate marine mineral resources and their economic significance.

CO4: Understand the structure, composition, and dynamics of the Earth's atmosphere and climate.

Skills, employability and entrepreneurship: This paper is useful to the sister department students of the Earth Science, such as chemistry, physics, life sciences, statistics, computer as well as computing sciences. Usually science students other than earth science qualify NET exams/interviews in the institutes join earth science related organizations, and they have to learn earth, atmosphere and ocean science in their area of research. However, with the knowledge of this subject (earth science), students can perform better in their career thereby utilizing the intension of studying the interdisciplinary science. Students have employability in many branches of science in different government organizations and MNCs.

OCEANOGRAPHY		42 hrs
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, consistency 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 used 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.	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, coal petroleum and natural gas, gas hydrates, poly-metallic nodules, metals enriched crusts, hydrothermal and metalliferous sediments. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	8 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: difference between weather and climate, climate and its classification, climate change, climate cycles. Paleoclimatology: introduction, tools/proxies for studying paleoclimatology. Interactive sessions of teaching to enhance students-teacher interactions through hands-on demonstrations and exercises in the recent advancement of the subject related to the curriculum.	8 hrs

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- 1) Physical Geology - C. W. Montgomery-Wm. C. Brown Publishing Co. Ltd (1993).
- 2) Physical Geology - A. N. Strahler.
- 3) Meteorology - William L. Donn (1975) - McGraw-Hill Book Co., New York.
- 4) An introduction to Dynamic Meteorology - J. R. Holton (1992) - III Ed, Academic Press.
- 5) Carol M. Lalli and Timothy R. Parsons. Biological Oceanography: An
- 6) Introduction (1997).
- 7) Miller, C.B. (2004) Biological Oceanography. Blackwell Publishers. 416pp.
- 8) Paul R. Pinet (1992) Oceanography: An introduction to the Planet Oceanus, West Publ., Co.571pp.
- 9) George Karleskint, Richard Turner, James Small, (2012) Introduction to Marine Biology Publisher: Brooks Cole, 512 pp.
- 10) Fasham, Michael J.R. (2003) Ocean Biogeochemistry. The Role of the Ocean Carbon Cycle in Global Change Series.
- 11) Carter, R.W.G., and Oxford, J.D. (1984) Coarse clastic barrier beaches: a discussion of the distinctive dynamic and morpho-sedimentary characteristics. Marine Geology 60: 377-89.

- 12) Komar, P. D., (1976) Beach Processes and Sedimentation, Prentice-Hall. 429p.
- 13) Reddy M.P.M. (2001) Descriptive Physical Oceanography, AA Balkema Press. 440p.
- 14) Abdulin, F.: Petroleum of Oil and Gas (1985).
- 15) Sidorov, N. A.: Drilling Oil and Gas wells (1985).
- 16) G.S. Roonwal: The Indian Ocean: Exploitable Mineral and Petroleum Resources (1986).

FOURTH SEMESTER

This Course will enable students to:

CO1: Independently conceptualize, design, and execute a research project.

CO2: Synthesize and critically analyze research findings.

CO3: Communicate complex scientific research effectively through written and oral presentations.

CO4: Apply professional standards and ethical considerations in research and reporting.

CO 5: Disseminate research results through publication.

Skills, employability and entrepreneurship: This semester is dedicated to dissertation work related to all branches of earth, atmosphere, ocean and space science, including subjects related to societal aspects. Students learn skills to work with the public, private sectors, universities and research institutions generally outside the university to provide better exposure related to earth, atmosphere and ocean science to compete at national (and international) levels. Students who qualify MSc in Marine Geology with dissertation will have ample opportunities in terms of developing skills, employability in research organizations, both in public, private sectors, universities and research institutions, and overseas fellowships/employment. They can develop skills to start their own entrepreneurship.

MGP 251: Dissertation and Viva-Voce	
Dissertation	
Dissertation: Each student is required to undertake a project work under the supervision of a faculty member. It shall consist of 32 hours of Project work per week and include the entire fourth semester and the students shall carry out their project work either in a software company, GIS application company, Remote Sensing company or any research institution such as NIO, INCIOS, CESS, C-GIST, NCAOR, etc. In-house project work with an affiliation of an external company or research institution with an external guide will also be considered for project work in the last (fourth) semester. The project work will be used to provide a dissertation that shall be submitted to the Chairman BoE. For evaluation as per the regulations for Marine Geology. A viva-voce shall be mandatory as provided in the regulations for Marine Geology M.Sc. course. After the dissertation work is completed, students shall submit dissertation based on the results obtained. The dissertation is evaluated by internal and external examiners. The total of the fourth semester shall be of 16 credits only.	200 marks
Viva-Voce	
Dissertation viva –voce: Each student has to present the dissertation work carried out by him/her in front of the examination committee that comprising of Guide, Chairman of the department and the external examiner(s).	100 marks

MODEL QUESTION PAPER

-----Semester M. Sc. in Marine Geology Degree Examination, Month---Year---
(CBCS system)

Subject code ----- : Title of the paper-----

Time: 3 Hours

Max. Marks: 70

Instructions: Answer all the questions

I. Define/state any **FIVE** the following:

5x 2= 10

- 1)
- 2)
- 3)
- 4)
- 5)
- 6)
- 7)

II. Write short notes on any **FIVE** of the following:

5 x 6 = 30

- 8)
- 9)
- 10)
- 11)
- 12)
- 13)
- 14)

III. Answer any **THREE** of the following:

3 x 10 = 30

- 15)
- 16)
- 17)
- 18)

Note to the question paper setter: give equal weightage to all the units.

Dr. Manoharan A N Member	Dr. R Nirmala Member
Smt. Yamuna S M Member	Dr. Avinash Kumar Member
Prof. Dwarakish G S Member	Dr. Priya K Chairperson

