DEPT. OF MARINE GEOLOGY & GEOPHYSICS

School of Marine Sciences, Lakeside Campus
Cochin University of Science and Technology
Kochi-16, Ernakulam, Kerala

Outcome Based Syllabus for

M.Sc. MARINE GEOPHYSICS

Effective from 2024 Academic Year

CONTENTS

1. About the Department

Cochin University of Science and Technology (CUSAT) was the first University in the Country to start a full-fledged post graduate programme in Marine Geology in the year 1976, taking into account the global advancement in general and national needs in particular in the field of Marine Geosciences. A three year M.Sc. (Tech) programme in Marine Geophysics was subsequently introduced in 1992 as a logical extension within the framework of a UGC funding of 1.27 crores to the existing Marine Geology programme, which has now been restructured into a 2-year MSc programme in Marine Geophysics. Both the programmes are complementary in nature and have been designed to aim at the development of manpower in the field of applied Geology and Geophysics with a special emphasis on offshore areas with a view to cater the needs of various research institutions and survey organizations as well as private companies engaged in oil and mineral exploration, seabed surveys, remote sensing and groundwater prospecting.

2. About the Programmes

The Earth, in particular the Ocean, is an unending mystery and needs to be answered.

How did the Earth originate? How the Oceans are formed? Was it due to a large collision of lithospheric plates or due to some other causes? Has the moon originated from the earth? What does the ocean bottom look like? Why are there some islands in the middle of the ocean? How and why do earthquakes occur? How do tsunamis form? Does the sea level change or was it the same for a long time? What is the role of the ocean on human survival? Where are the natural resources present? How to explore these resources?

Marine Geologists and Marine Geophysicists attempt to answer these questions and worse - they bring up more questions!

Oceans that cover one third of the Earth's surface hide many of the realities about the formation and evolution of the Earth. Even today vast amounts of the Earth's surface is created and destroyed beneath the oceans. The oceans give the opportunity to scour much of the surface of the earth unhindered by Geographical or political boundaries. Besides the Oceans are the store houses of both renewable and non-renewable resources - much more than the fast depleting deposits on the land.

3. Scope

This curriculum and syllabi are applicable to the Marine Geology and Marine Geophysics M.Sc. programmes of the School of Marine Sciences of Cochin University of Science and Technology (CUSAT).

4. Definition of Keywords

Choice Based Credit System (CBCS): As per the UGC Guidelines on Adoption of Choice Based Credit System and the CBCS implementation guidelines of CUSAT, the CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses).

Outcome Based Education (OBE): As per the Template of Outcome Based Education (OBE) Curriculum by UGC and implementation guidelines of CUSAT, OBE is starting with a clear picture of what is important for students to be able to do and achieve (Knowledge, Skill and Ability) then organizing the curriculum, instruction, and assessment to make sure this learning ultimately happens.

Credit Based Semester System (CBSS): As per the UGC Guidelines on Adoption of Choice Based Credit System and the CBCS implementation guidelines of CUSAT, under the CBSS, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be completed by the students.

Cumulative Grade Point Average (CGPA): It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

PG Regulation: The regulations and guidelines issued by CUSAT, from time to time, for the conducting master degree programmes in the University.

Core Course (CC): means a course that the student admitted to a particular programme must successfully complete in order to receive the Degree and which cannot be substituted by any other course. Core courses ensure that students have a common base of knowledge and skills necessary to advance in their chosen field.

Elective Course (EC): Elective course means a course, which can be substituted by equivalent courses from the same or other Departments/Schools. Elective courses are optional courses that students can choose to take based on their interests, career goals, or academic requirements. Elective courses often cover specialised topics within a field of study, advanced subjects, or interdisciplinary areas that complement a student's primary knowledge framework.

Massive Open Online Courses (MOOC): The online courses that fully satisfy the guidelines of the Regulations for conducting MOOC of CUSAT.

5. Programme Objectives

The objective of the MSc Geophysics program is to equip students with the essential knowledge and skills necessary for excelling in the field of Earth Sciences by providing a comprehensive understanding of geophysical principles, methodologies, and technologies. Through a balanced curriculum, students will develop perspectives, analytical capabilities, and decision-making skills vital for leadership roles in industries and research institutions operating in a dynamic geological and environmental landscape. The MSc Geophysics program focuses on preparing students for careers in geophysical exploration, resource management, environmental assessment, and research endeavors across various sectors globally. Students will gain a solid foundation in geophysical theories, methodologies, and instrumentation, enabling them to analyze complex geological structures, interpret subsurface properties, and make informed decisions in exploration, engineering, and environmental management projects.

6. Programme Specific Outcomes (PSOs) of M.Sc. Marine Geophysics

On successful completion of M.Sc. Marine Geophysics programme, graduates will be able to:

PSO 1	High quality academic/ research experience and expertise in Marine Geophysics.
PSO 2	Skill development in offshore and onshore resource mapping, exploration and development.
PSO 3	Expertise in field data collection, analysis and interpretation to study structure and tectonic evolution.
PSO 4	To probe the interior of the earth for structural, tectonic and exploration studies using geophysical data.
PSO 5	Disaster management and environmental protection using space and terrestrial observations.

7. Course Outcomes

Course outcomes are specific and measurable statements that define the knowledge skills and attitude learners will demonstrate by the completion of the course. These are mapped with PSOs in the respective syllabus.

8. Programme Monitoring

The M.Sc. programmes in the Department of Marine Geology and Geophysics shall be monitored by the Department Council as per the "Regulation for Post Graduate Programmes Under Choice Based Credit System (CBCS) Offered by the University Departments/Schools/Centres" by CUSAT.

8.1. Programme Duration, Semesters and Credits

The M.Sc. programme has duration of two years (four semesters). In order to complete the M.Sc. programme, a student is required to obtain a total of 80 credits. The credit distribution of the M.Sc. programme is given in the following table.

Sl. No.	Courses	CC/EC	No. of Courses	Total Credit
1	Core Courses (Other than Summer Project / Dissertation & Viva Voce)	CC	23	53
2	Summer Project / Dissertation & Viva Voce	CC	01	16
3	Elective Courses	EC	09	24
4	MOOC Course	CC	01	03
	Total Courses		**34**	**96**

Note: CC – Core courses and EC – Elective Courses

8.2. Delivery of Courses

Through a dynamic blend of traditional lectures, fieldwork, and experiential learning opportunities, students in the MSc Marine Geophysics program must be deeply engaged with real-world challenges and develop critical analytical skills. Fieldwork serves as a cornerstone, offering first-hand insights into complex marine geological and geophysical phenomena, encouraging strategic thinking, and honing decision-making abilities. Moreover, experiential learning components such as data analysis projects and internships provide hands-on exposure, allowing students to apply theoretical knowledge in authentic research settings. This multifaceted approach is essential to cultivate a comprehensive understanding of marine geological and geophysical concepts, coupled with the agility and adaptability necessary for success in today's dynamic global marine environment.

8.3. Interdepartmental Electives

The M.Sc. programmes follow CBCS and thus the interested students may opt for elective courses offered by the allied Schools/Departments in CUSAT as inter-department elective course(s) subject to the regulations/guidelines prescribed in this regard by the University.

8.4. MOOC Course

India's National MOOC platform 'SWAYAM' (Study Webs of Active–Learning for Young Aspiring Minds) was launched in July 2017. The objective of the programme is to make available the best teaching learning resources of an Institution to all, including the most disadvantaged. As per the UGC (Credit Framework for online learning courses through SWAYAM) Regulation 2016, Universities can identify courses where credits can be transferred on to the academic record of the students for courses done on SWAYAM. Up to 20% of the total credit in each semester can be based on online courses offered through SWAYAM Platform (www.swayam.gov.in). Courses delivered through SWAYAM are available free of cost to the learners, and students are advised to register for the final proctored exams, some of which come at a fee and attend in person at designated centres on specific dates, so as to get SWAYAM certificate. Universities/colleges approving credit transfer for these courses can use the marks/certificate obtained in these courses for the same. With this prelude, the curriculum based syllabus M.Sc. Marine Geophysics Programme is designed based on the Outcome Based Education.

It is mandatory for the students to register for a suitable MOOC (as recommended by Department Council from time to time), available in the SWAYAM platform (www.swayam.gov.in). The students can avail the courses at any time during the first three semesters, based on the availability of suitable courses at www.swayam.gov.in and should procure the required credits for MOOC before completion of the fourth semester. Grading of MOOC will be decided by the Department Council and University based on the results obtained from www.swayam.gov.in

8.5. Summer Project / Dissertation

Students of the M.Sc. Marine Geology and Geophysics program shall undertake a Summer Project / Dissertation after completion of the third semester. The aim of this project is to provide students with an opportunity to gain practical experience in geological and geophysical research, familiarizing them with fieldwork techniques and problem-solving exercises relevant to their area of specialization.

The Summer Project shall be geological/geophysical study attached to a research institution and government agency engaged in research and exploration. Students will complete the project within 4 months, under the supervision of a faculty member assigned by the School/recognized institutions.

During the project, students will apply theoretical knowledge acquired during their coursework to address specific research questions or practical challenges in geology and geophysics. They will utilize research methodology tools in a systematic manner to collect, analyse, and interpret data, culminating in a comprehensive report documenting their internship learning experience and study findings.

The evaluation of the Summer Project and the awarding of marks and grades shall be based on Continuous Assessment (CA) and a final project presentation. If a student does not achieve the required pass mark for the project, they may need to redo the project work and obtain a pass grade along with the next batch of students.

9. OUTCOME BASED SYLLABUS FOR M.Sc. MARINE GEOPHYSICS

Dept. of Marine Geology & Geophysics
Cochin University of Science and Technology
(Effective from 2024 Academic Year)

SEMESTER-I

Course Code	Paper	Core/ Elective	Credit	Marks CA	SEE	Total
24-317-0101	Physics of The Earth and Geodynamics	Core	3	50	50	100
24-317-0102	Mathematical Geophysics	Core	3	50	50	100
24-317-0103	Gravity and Magnetic Prospecting	Core	4	50	50	100
24-317-0104	Structural Geology and Geotectonics	Core	3	50	50	100
24-317-0105	Computer Programming in Earth Sciences (Practical)	Core	2	100	-	100
24-317-0106	Gravity and Magnetic Computations (Practical)	Core	2	100	-	100
24-317-0107	Structural Geology (Practical)	Core	1	100	-	100
24-317-0108	Elective – 1	Elective	3	50	50	100
24-317-0109	Elective - 2	Elective	3	50	50	100
24-317-0110	Elective - 3	Elective	3	50	50	100

SEMESTER-II

Course Code	Paper	Core/ Elective	Credit	Marks CA	SEE	Total
24-317-0201	Electronics for Instrumentation	Core	3	50	50	100
24-317-0202	Seismology	Core	3	50	50	100
24-317-0203	Remote Sensing & GIS	Core	3	50	50	100
24-317-0204	Well Logging	Core	3	50	50	100

24-317-0205	Electrical & Electromagnetic Prospecting	Core	3	50	50	100
24-317-0206	Electronics (Practical)	Core	1	100	-	100
24-317-0207	Electrical & Electromagnetic Prospecting (Practical)	Core	1	100	-	100
24-317-0208	Seismology (Practical)	Core	1	100	-	100
24-317-0209	Remote Sensing & GIS (Practical)	Core	1	100	-	100
24-317-0210	Elective - 4	Elective	3	50	50	100
24-317-0211	Elective - 5	Elective	2	50	50	100

SEMESTER-III

Course Code	Paper	Core/ Elective	Credit	Marks CA	SEE	Total
24-317-0301	Digital Signal Processing	Core	3	50	50	100
24-317-0302	Seismic Prospecting	Core	3	50	50	100
24-317-0303	Offshore Exploration	Core	3	50	50	100
24-317-0304	Groundwater Geophysics	Core	3	50	50	100
24-317-0305	Geophysical Field Work (Practical)	Core	1	100	-	100
24-317-0306	Digital Signal Processing (Practical)	Core	1	100	-	100
24-317-0307	Seismic Prospecting (Practical)	Core	1	100	-	100
24-317-0308	Geological Field Work	Core	1	50	50	100
24-317-0309	Elective - 6	Elective	3	50	50	100
24-317-0310	Elective - 7	Elective	3	50	50	100
24-317-0311	Elective - 8	Elective	2	50	50	100
24-317-0312	Elective - 9	Elective	2	50	50	100

SEMESTER-IV

Course Code	Paper	Core/ Elective	Credit	Marks		Total
				CA	SEE	
24-317-0401	Project Work, Presentation and Viva Voce	Core	16	100	-	100
24-317-0402	MOOC Course***	Elective	03	-	100	100

Total number of credits for all the four semesters (Core Course)	69
Minimum number of credits to be taken as Elective Course	08
Minimum number of credits to be taken as MOOC*** Course.	03
Minimum number of credits required for the completion of M.Sc. Marine Geophysics Programme	80

Elective courses offered by the Department#

Course Code	Paper	Electives	Credit
24-317-0108	General Geology*	Elective-1	3
24-317-0109	Physical Geology & Geomorphology**	Elective-2	3
24-317-0110	Environmental Geology & Disaster Management	Elective-3	3
24-317-0210	Stratigraphy and Indian Geology	Elective-4	3
24-317-0211	Sequence Stratigraphy	Elective-5	2
24-317-0309	Marine Geology	Elective-6	3
24-317-0310	Petroleum Geology and Coal Geology	Elective-7	3
24-317-0311	Mining and Exploration Geology	Elective-8	2
24-317-0312	Geo-Statistics	Elective-9	2

* For Non Geology Graduates
** For Geology Graduates

******* It is mandatory for the students to register for a suitable MOOC (as recommended by Department Council from time to time), available in the SWAYAM platform (www.swayam.gov.in). The students can avail the courses at any time during the first three semesters, based on the availability of suitable courses at www.swayam.gov.in and should procure the required credits for MOOC before completion of the fourth semester. Grading of MOOC will be decided by the Department Council and University based on the results obtained from www.swayam.gov.in

10. Syllabus for M.Sc. Marine Geophysics Programme

10.1. Semester I

24-317-0101	PHYSICS OF THE EARTH AND GEODYNAMICS	Core	Credit 3

Sl. No.	Outcomes	Bloom's Level
1	Understanding the formation, evolution, structure, composition and the thermal structure of Earth	2
2	Apprehension of the motions of Earth, Basics of Geodesy, Gravity and Magnetic field properties and concept of plate tectonics	3
3	Have information about the mechanical properties of the Earth and the forces that lead to the creation of a geologic structure and how they may act over a regional scale	2
4	Understand the composition of the continental and oceanic crust. Analyse the deformation over ocean and continents and explain the geomagnetic time scale	2
5	Knowledge about Earth's radioactivity, thermal and electrical properties	3

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	-	3	2
CO2	1	-	2	3	-
CO3	1	3	2	-	1
CO4	1	3	1	2	-
CO5	1	3	1	3	2

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit-I

Earth as a planet: Solar system- its formation, different planets, satellites and meteorites. General introduction to formation and evolution of earth and moon. Kepler's laws of planetary motion. Chemical composition of the Earth; interacting earth systems. Internal structure of the earth.

Unit-II

Geodesy and Gravity, Geoid, Ellipsoids, Datums, Coriolis effect, size and shape of the earth, Normal Gravity field. Isostasy – Airy, Pratt and VeningMeinesz models. Geomagnetism: Components of the field, long and short period variations, Magnetosphere, Geodynamo. Rock Magnetism, Palaeomagnetism. Geomagnetic time scale; Plate Tectonics in relation to paleomagnetism.

Unit-III

Thermal regime over continents and oceans: Importance of heat flow studies, geothermal gradient; nature of heat sources in the crust and mantle; heat flow in continents and oceans; areas of anomalous heat flow, Hotspots and mantle plumes.

Unit-IV

Lithosphere Dynamics: Composition of the upper and lower continental crust, oceanic crustal structure and different layering. Asthenosphere - definition, structure and mechanical properties. Mantle viscosity and convection. Rheology: Brittle and ductile deformation, viscous flow in liquids and solids, creep. Effective elastic thickness, thermal structure and rigidity of lithosphere, loading and deformation, admittance analysis and back stripping; rheological difference between continental and oceanic lithosphere.

Unit-V

Earth's Radioactivity, Thermal and Electrical properties: radiation, radioactivity, half-life, decay constant, radioactive equilibrium, radioactive minerals, measurement techniques, rock dating techniques – U-Th-Pb, K-Ar, C14, Rb-Sr, Re-Os, Sm-Nd, Fission-track, Magnetic dating.

References:

- The earth and its gravity field, Heiskanen. A.A. and Veningmeinesz F., 1958, Mc GrawHill.
- Applied Geophysics, Telford W.M., Geldart L.P. and Sherif R.H., 1997, Cambridge.
- Geodesy: Introduction to Geodetic Datum and Geodetic Systems, 2014, Springer.
- Physics of the Earth, Frank D. Stacey, 2008, Cambridge.
- Deep Earth: Physics and Chemistry of the Lower Mantle and Core, HidenoriTerasaki and Rebecca A. Fischer (Editors), 2016, Wiley.
- Plate Tectonics, X. Le Pichon, Jean Francheteau and Jean Bonnin, 1973, Elsevier.
- Interior of the Earth, Bott M.H.P., 1971, Hodder & Stoughton Educational.
- Geodynamics, Turcotte and Schubert DL., 2014, Cambridge
- Fundamentals of Geophysics, William Lowrie, 2007, Cambridge
- The Solid Earth Geophysics: An Introduction to Global Geophysics, Fowler C.M.R., 2005, Cambridge.

24-317-0102	MATHEMATICAL GEOPHYSICS	Core	Credit 3

No	Outcomes	Bloom's Level
1	Understanding of fundamental mathematical concepts such as calculus, linear algebra, differential equations, and probability theory	2
2	Develop proficiency in numerical methods and computational techniques for solving geophysical problems	3
3	Acquire skills in statistical analysis and data interpretation, allowing them to analyze geophysical data sets	4

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	-	2	-	-
CO2	1	-	3	-	-
CO3	1	-	2	-	1

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit-I

Scalar and vector fields. Field and potential, Vector equations, Differentiations, gradient tangent plane, divergence and curl. Integrations, surface and volume integrals, Green, Gauss, and Stokes theorems and their applications. Laplace and Poisson’s equations, Maxwell's equations.

Unit-II

Complex variables: Analytic function, Cauchy's theorem, Laurent series, residues of analytic and contour integration, applications in geophysics

Integral transforms: Fourier transform, Laplace transform and their applications in geophysics.

Unit-III

Numerical solution of partial differential equations: Classification of linear partial differential equations, wave and diffusion equations, Laplace equations, and their applications in geophysics.

Unit-V

Analysis of statistical and variance analysis, tests of significance and their applications in geophysics.

References:

- Sastry: Introduction Methods of Numerical analysis
- Gerald: Applied Numerical Analysis
- Gerald et. al.: Finite Element Simulation in Surface and Subsurface Hydrology
- Bath: Mathematical Aspects of Seismology
- Jain, Iyengar & Jain: Numerical Methods for Scientific and Engineering Computation
- Jain: Numerical Solution of Differential equations
- Mitchell: Computational Methods in Partial Differential Equations

24-317-0103	GRAVITY AND MAGNETIC PROSPECTING	Core	Credit 4

No	Outcomes	Bloom's Level
1	Understand the concept of potential, field and its theories	2
2	Familiarise the concept of gravity and magnetic anomaly and the physical quantities that produce them	3
3	Demonstrate the instrumentation and survey methods involved in the prospecting method	4
4	Carry out the field procedures, processing and modelling of gravity and magnetic data	4

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	-	2	1
CO2	1	1	2	3	2
CO3	3	2	3	1	1
CO4	1	2	3	1	1

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit-I

Introduction: Force field, Potential field and its classification. Newtonian potential and its properties. Concept of Equivalent stratum, Geoid and Ellipsoid, Isostasy, Spatial and temporal variation of gravity and magnetic fields and anomalous field. IGRF, Density and Susceptibility of rocks and minerals, Measurement of density and susceptibility, in-situ measurements, Concept of anomaly.

Unit-II

Instrumentation: Static and Astatic gravimeters, Astatic Zero length spring, Worden and Lacoste Romberg gravimeters. Magnetometers: Total field measurement: Proton Precession Magnetometers, optically pumped magnetometers, fluxgate, Variometers: induction coil. Gradiometers. Ship-borne and air-borne gravity and magnetic instrumentations.

Unit-III

Field procedures: concept of base station, recording station, planning of surveys, traverse and profile, station spacing, diurnal and secular variations. Surveying in a grid. Airborne and ship-borne surveys.

Unit-IV

Data reduction and processing: Reduction of gravity data. Reduction of magnetic data. Anomaly and its visualization. Anomalies of gravity field – Free-Air, Bouguer and Isostatic anomaly. Magnetic anomaly. Data reduction in Marine Surveys.

Unit-V

Data Processing and Modelling: Image Enhancement Techniques: Regional-Residual Separation, Analytic continuation, vertical derivatives. Reduction to pole. Ambiguity in interpretation. Euler deconvolution, Werner deconvolution. Depth estimation procedures. Interpretation of data, identification of structural features. Modelling: Forward response of bodies: Gravity anomaly of point and line masses, sheets circular discs, vertical cylinders, rectangular slabs, dykes, faults and irregular geometries. Magnetic anomaly of monopole, dipole, sphere, cylinder, sheet, dyke, fault and irregular geometries. Preparation of pseudo-gravity map from magnetic data. Modelling of sedimentary basins.

Unit-VI

Applications: Applications in petroleum exploration- salt domes, structural traps. Application in mineral exploration - sulphide ores, placers, diamonds. Application in crustal studies-basins, faults etc, groundwater and other natural resources on land and marine.

References:

- The Earth and its gravity field, Heiskanen. A.A. and Veningmeinesz F., 1958, Mc GrawHill.
- Gravity and magnetics in oil prospecting, Nettleton. L.L., 1976, Mc Graw-Hill.
- Gravity and magnetic methods of prospecting, Rao. B.S.R. and I.V.R. Murthy, 1978,Arnold-Heinemann.
- Gravity, Tsuboi C., 1983, harpercollins.
- Interpretation of gravity and magnetic anomalies in space and frequency domains,murthy I.V.R., 1989, Association of Exploration Geophysics.

- Applied Geophysics, Telford W.M., Geldart L.P. and Sherif R.H., 1997, Cambridge.
- An Introduction to Geophysical Exploraton, Philip Kearey, Michael Brooks and IanHill,2002, Wiley.
- Potential Theory in Applied Geophysics, 2008, Springer.
- Gravity and Magnetic Exploration: Principles, Practices, William J.H., Ralf R.B., VonF. and Afif H. Saad, 2013, Cambridge.
- Acquisition and Analysis of Terrestrial Gravity Data, Long L.T. and Kaufmann R.D.,2013, Cambridge.
- Introduction to Geophysical Prospecting, Milton B. Drobrin and Carl H. Savit, 2014,Mc Graw Hill.
- Advances in Gravity and Magnetic Processing and Interpretation, FairheadJ.D., 2015,Eage.
- Marine Geophysics, Jones E.J.W., 2016, Wiley.

24-317-0104	STRUCTURAL GEOLOGY AND GEOTECTONICS	Core	Credit 3

No	Outcomes	Bloom's Level
1	To give an in-depth knowledge of different geological structures associated with deformation processes	2
2	Basic concepts of the rheological properties of rocks and their control on the deformation processes	1
3	Geometric description of the structures observed in natural deformed rocks.	2
4	Provide skills in geological mapping and site investigation	4
5	To have a knowledge about Plate tectonics	3

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	3	2	1
CO2	1	1	2	3	1
CO3	2	1	3	3	1
CO4	1	3	1	-	1
CO5	1	3	3	3	1

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit I:

Concept of stress and strain.Types of stress – lithostatic, comprehensive, shear, biaxial,triaxial, mean and deviatoric. Stress analysis – principal planes and axes. Strain – dilation and distortion, strain ellipse and strain ellipsoid. Types of strain – homogeneous and inhomogeneous simple and pure, rotational and irrotational.Stages of homogeneous strain.

Unit II:

Stages of rock deformation and factors affecting them – confining pressure strain rate, fluid medium and temperature.Competence and incompetency of rocks.Behavior of common rock types to stress.

Unit III:

Folds – definition and geometry of folded surface. Geometric classification and nomenclature. Mechanics of folding and genetic classification. Faults – geometry and nomenclature. Types of faults and fault systems.Dynamics of faulting. Conditions and factors affecting rupture. Deep crustal faults and transform faults. Recognition of faults and features along the fault plane.

Unit IV:

Shear Zones – types, geometry and mechanism of formation. Brittle, ductile and brittle – ductile shears and associated structures. Thrusts – large – scale thrusts and their tectonic significance. Unconformities – classification, recognition and geological significance.Importance of unconformity in tectonostratigraphic correlation.Joints- geometry types and genesis.Tectonites:classification, tectonic fabric. Lineation – definition, types classification and origin.Foliation – definition and types. Axial plane foliation and its origin.Use of axial plane foliation and fracture cleavage in structural analysis.

Unit V:

Geological mapping – Techniques involved in mapping various types of geological terrain of undeformed to poly deformed nature. Peterofabric analysis – field and laboratory techniques involved in the construction of fabric diagrams and their interpretation.

Unit VI:

Fundamental concepts of Geotectonics; recent advances, dynamic evolution of continental and oceanic crust; tectonics of Precambrian orogenic belts of India; tectonic framework of India; seismicity in India. Formation of mountain roots; anatomy of the orogenic belts; structure and origin of the Alpine- Himalayan belt, Appalachian- Caledonian belt, Andes and North- American Cordillera.

References:

- Fundamentals of Structural Geology 3rd Edition, R. G. Park, 2013, Routledge
- Fundamentals of Structural Geology, D. D. Pollard & R. C. Fletcher, 2005, Cambridge University Press
- An Outline of Structural Geology, B. E. Hobbs, W. D. Means & P. F. Williams, 1976, John Wiley and Sons Ltd
- Structural Geology by Marland P. Billings, 2000, Phi Learning.
- Structural Geology by Robert J. Twiss, Eldridge M. Moores, 2006, W. H. Freeman publisher.
- Techniques of Modern Structural Geology. Vol. I. Strain Analysis, Ramsay, J.G. and Huber, M.I., 1983, Academic Press.
- Folding and fracturing of rocks, Ramsay, J.G., 1967, McGraw Hill. And Modern Developments, Ghosh, S.K., 1993, Pergamon Press.
- Moors, E. and Taiss, R.J. (1995) Tectonics
- Keary, P and Vine, F.J. (1990); - Global Tectonics
- Elements of Engineering Geology, Richy J. E., 1968, Pitman
- Engineering and General Geology, Parbin Singh, 2013, S.K. Kataria& Sons

24-317-0105	COMPUTER PROGRAMMING IN EARTH SCIENCES (PRACTICAL)	Core	Credit 2

No	Outcomes	Bloom's Level
1	Understand the basics of programming languages	2
2	Formulate simple computer programs in Python	5
3	Data Analysis of geophysical datasets Using MATLAB	4
4	Experience in Generic Mapping Tool (GMT)	3

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	-	2	-	-
CO2	1	-	3	-	-
CO3	1	-	2	-	1
CO4	2	-	3	-	-

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

- Python: Introduction to python, variables, data types, reading and printing of files, mathematical operators, conditional statements, loop statements- while and for loop; scripting for geophysical problems
- Matlab: Introduction to Matlab; Arrays; vectors and matrices; Array indexing; linear and logical indexing; plotting commands for line, polar, rose, contour and others shapes, histograms and images; Matrix operations Example codes for geophysical problems.
- Introduction to Generic Mapping Tool, (GMT) and basic commands in GMT; psbasemap, psxy, pstext, psimage, pscontour and other plotting commands.

24-317-0106	GRAVITY & MAGNETIC COMPUTATIONS (PRACTICAL)	Core	Credit 2

No	Outcomes	Bloom's Level
1	Understand the basic principles of surveying, field procedures, handling with Toposheets and GPS	2
2	To have knowledge about the working principle, survey procedures, data acquisition and data processing, of gravity and magnetic instruments and their calibrations	3
3	To be able to explain various principles of interpretation of gravity and magnetic data in terms of geological expression	4
4	To generate different gravity and magnetic anomaly maps and their interpretation in terms of subsurface geology	5

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	3	2	1
CO2	3	1	3	1	-
CO3	1	2	1	3	-
CO4	2	1	2	3	1

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

- Introduction: Definition; principles; types and various applications of surveying; Field and office work; Scale of a map or plan. Study of Toposheets.
- Surveying with GPS: Determination of positions: GPS-principle and its uses. Handling of gravimeter, Magnetometers and calibration.
- Preparation of gravity and magnetic anomaly contour maps from field data Density estimation using Nettleton's method. Regional – residual separation methods in gravity and magnetic methods Upward and downward continuation and derivative maps of gravity and magnetic fields

- Construction of gravity and magnetic profiles on some simple geometrical models, Depth Estimation. Interpretation of gravity and magnetic anomalies obtained over different geological structures.
- Near surface Geophysical observations using Gravity & Magnetic Methods

24-317-0107	STRUCTURAL GEOLOGY (PRACTICAL)	Core	Credit 1

No	Outcomes	Bloom's Level
1	Understanding the geological folds, faults, lineaments etc.	2
2	Estimation of fault parameters	4
3	Interpretation of structural maps	5

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	3	2	2
CO2	1	1	3	2	1
CO3	1	2	2	2	1

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

- Study and description of different kinds of megascopic folds in hand specimens
- Trigonometric methods in dip and apparent dip relations, thickness of strata, fault problems.
- Descriptive geometry applied to intersection of two planes, vertical and inclined faults, and structural contours
- Interpretation of structural maps. Stereographic methods in dip and apparent dip, plunge and intersection of planes and lines.

24-317-0108	GENERAL GEOLOGY	Elective	Credit 3

No	Outcomes	Bloom's Level
1	Understand the origin of different structures in igneous, metamorphic and sedimentary rocks	2
2	Identify different rocks and rock forming minerals	3
3	Understand the weathering and erosional process of different geological agents and the associate landforms	3

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	3	2	1
CO2	1	1	3	1	1
CO3	1	1	3	1	1

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit I:

Constituent materials of the crust - rocks, minerals, fossils, soil and fluid constituents

Unit II:

Primary structures: Stratification and other common primary structures in sedimentary and igneous rocks. Rock deformation: stress and strain – stages of deformation behaviour of rocks under stress

Unit III:

Mineralogy - elementary concepts of geometric crystallography - simple forms and combinations - physical and chemical characteristics of minerals and their classification. Brief study of common rock-forming and ore minerals.

Unit IV:

Rocks - classification, form, texture and mineralogy of common igneous, sedimentary and metamorphic rocks/rock-groups. Petrogenetic processes – magmatism and related processes – deposition and lithification of sediments – Geological work of streams, glaciers, wind, sea and groundwater, Weathering – Physical and Chemical weathering- Sediment transport and erosion - metamorphic processes.

Unit IV:

Geologic time scale – significance of study of fossils and geochronological methods in Geology.

References:

- Understanding Earth 4th Edition, Frank Press & Raymond Siever, 2003, W. H. Freeman
- Principles of Physical Geology, Arthur Holmes, 2016, Wiley
- Petrology for students, S. R. Nockolds, R. W. O'B. Knox, G. A. Chinner, 1978, Cambridge University Press 20-316-0108: PHYSICAL

24-317-0109	ENVIRONMENTAL GEOLOGY & DISASTER MANAGEMENT	Elective	Credit 3

No	Outcomes	Bloom's Level
1	Understanding and awareness of environmental problems.	2
2	Pollution investigations and its impacts.	5
3	Familiarise geological hazards and mitigation measures.	2

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	-	1	2	-	3
CO2	-	-	2	-	3
CO3	-	1	1	1	3

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit-I

Environmental Geology: definition and concepts of environmental geology; environmental problems: greenhouse effect, global warming, global boiling and its consequences, mitigation and adaptation; depletion of ozone layer, acid rain.

Unit-II

Pollution and its impacts: Air pollution: causes, impact and remedial strategies; Noise pollution: causes, impact and remedial strategies; Water pollution: causes, impact and remedial strategies; groundwater pollution and health issues.

Unit-III

Environmental analysis of mining activities: concept of eco-friendly mining, laws governing protection of environment and control of pollution, environmental impact assessment (EIA). Environmental Management Plan (EMP).

Unit-IV

Disaster management: Definitions and concepts: Hazards, disaster and catastrophe, Types and classification, causes and factors affecting disasters. Impact of disasters. Human behaviour and response during disaster; natural hazards: earthquakes, volcanic activities, floods, droughts, landslides.

Unit-V

Disaster risk assessment, preparedness and mitigation: Management and mitigation of disasters. Risk analysis, evaluation vulnerability assessment, Hazard zonation mapping and modeling, risk reduction strategies.

References:

- Patrick, L.A., (2016), Natural Disasters, McGraw Hill
- Carla, W. M., (2013) Environmental Geology, McGraw-Hill Education.
- Subramaniam, V., (2001) Text Book in Environmental Science,Narosa International.
- Bell, F. G., (1999) Geological Hazards.,Routledge, London.
- Krynine, D. H. and Judd, W. R., (1998) Principles of Engineering Geology., CBS Edition.
- Smith, K., (1992) Environmental Hazards., Routledge, London
- Bryant, E., (1985) Natural Hazards., Cambridge University Press.
- Keller, E. A., (1978) Environmental Geology., Bell and Howell, USA .
- Valdiya, K.S., (1987) Environmental Geology – Indian Context., Tata McGrawHill
- Vogelsang D., (1995) Environmental Geophysics – A Practical Guide. Springer

24-317-0110	PHYSICAL GEOLOGY & GEOMORPHOLOGY	Elective	Credit 3

No	Outcomes	Bloom's Level
1	Understanding the basic concepts of physical geology which shape the surface	2
2	Ability to familiarize the geomorphic features and natural agents	5

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	3	1	1
CO2	1	1	2	1	1

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Physical Geology

Unit-I

Origin of the Earth – Geoid and Ellipsoid concepts on the shape of the Earth – seismology and internal structure of the Earth – composition of the Earth – Geological time scale.

Unit-II

Plate tectonics: Theories and concepts – major plates and plate movements – different types of plate margins – continent drift and polar wandering –seafloor spreading, geomagnetic reversals – hotspots – Supercontinent cycles – global tectonics.

Rheology and mechanical properties of the lithosphere – deformation of the lithosphere – Isostasy – types and distribution of Volcanoes – intensity, causes, focal mechanism, epicentral localization, and global distribution of earthquakes.

Geomorphology

Unit-III

Basic concepts of geomorphology: ancient and modern ideas – catastrophism – uniformitarianism, approach and ideas of geomorphology. Different models of evolution of landscape- Davis, Penck, King, Hack.

Fluvial Geomorphology: Laws of drainage, fundamental concepts of fluvial morphometry, Concept of grade, channel forms and processes, shape of channel, longitudinal slope, base level control relation between channel width, depth and current velocity.

Unit-IV

Geomorphic Processes and associated Landforms: Streams – Oceans and Coasts – Ground water – Deserts – Glaciers.

Unit-V

Mass movements: Hill slopes –different approaches to study of slopes and their evolution– slope movement and stability factors–types, causative factors, and classification of mass wasting – a case study of landslides in Kerala.

Soil forming process: Physical and chemical weathering – the dynamic soil– nature of soil– soil texture and classification –soil horizons.

References:

- Geomorphology: A systematic analysis of late Cenozoic landforms, Bloom A.L., 1978,Prentice-Hall
- Principles of Physical Geology 3rd Edition, Holmes A., 2016, Wiley
- Geomorphology in the tropics, Thomas M.F., 1994, John Wiley & Sons
- Regolith, Soils and Landforms, Oliver C.D. & Pain C.F., 1996, Wiley

10.2. Semester II

24-317-0201	ELECTRONICS FOR INSTRUMENTATION	Core	Credit 3

No	Outcomes	Bloom's Level
1	Familiarize with Integrated circuits and its application in geophysics	2
2	Programming using logic gates and microcontroller	4
3	Measurement of geophysical variables such as temperature, vibration, gravity etc	4

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	2	-	-
CO2	2	1	2	-	-
CO3	2	1	2	-	-

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Analog Electronics

Unit-I

Basics of operational amplifier (op-amp): offset voltage, offset current, open-loop gain, and slew rate; Amplifiers (built with op-amps): negative feedback, inverting, non-inverting, unity-gain (buffer), summing, and differential amplifiers; characteristics of amplifiers: input impedance, output impedance, voltage gain, and bandwidth; common mode rejection ratio

(CMRR) of differential amplifiers; Active Filters: low-pass, high-pass, band-pass, band-reject filters (Butterworth filters), and notch filter.

Unit-II

Oscillators: Berkhausen criteria, phase-shift, wien-bridge, and LC oscillators. Current-to-voltage converter, voltage-to-current converters, peak detector. Non-linear circuits with opamps: zero-crossing detector, comparators, and Schmitt trigger. 555 Timer IC: basic function of timer IC, astable and monostablemultivibrators with 555 timer IC.

Digital Electronics

Unit-III

Combinational logic: Basic logic gates and their truth-tables, simplification of truth-tables by Karnaugh map method, implementing simplified form of an arbitrary truth-table by sum-of-products (SOP) and product-of-sum (POS) methods; Programmable Array Logic (PAL) and its application; multiplexers, de-multiplexers, encoders and de-coders.

Unit-IV

Sequential logic: R-S, D, J-K flip-flops, counters (both synchronous and asynchronous), registers, latches, memory; various types of analog-to-digital (ADC) and digital-to-analog (DAC) converters.

Instrumentation

Unit-V

Static and dynamic characteristics of instruments, active and passive sensors, methods of transduction; measurement of temperature, optical radiation, nuclear radiation, vibration, gravity, magnetic field, and soil resistivity.

Basics of 8051 micro-controller: block diagram, programming (basics), and simple implementation of a typical instrument with this micro-controller (block-diagram).

References:

- Measurement systems: Applications and Design Engineering, Ernest O. Doebelin, 2003, McGraw-Hill Series in Mechanical and Industrial Engineering.
- Instrumentation: Devices and systems, C.S.Rengan, G.R.Sharma and V.S.V.Mani, 2004, McGraw Hill.
- Fundamentals of Instrumentation and Measurement, Dominique Placko, 2007, iSTE Instrumentation and Measurement Series.

- The 8051 Microcontroller, Kenneth J.Ayala, 2014, Cengage Learning India Pvt. Ltd.
- Digital Principles and Applications, Donald P. Leach, Albert Paul Malvino, GautamSaha, 2014, McGraw Hill Education.
- Instrumentation in Earthquake Seismology, Jens Havskov, Gerardo Alguacil, 2014, Springer.
- Op Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, 2015, Pearson.
- The Art of Electronics, Paul Horowitz & Winfield Hill, 2015, Cambridge.

24-317-0202	SEISMOLOGY	Core	Credit 3

No	Outcomes	Bloom's Level
1	Understanding the basics of Stress and Strain tensors, Elastic constants, Equation of motion	2
2	Acquire knowledge about the elastic waves propagation through interior of the Earth	2
3	Be acquainted with the working principle and the field establishment of the seismometers	3
4	Analyse the various sources of seismic waves, estimation of the source parameters using waveform modelling	4
5	Advanced knowledge in seismology integrating geodetic techniques, seismic tomography and paleo-seismology	3

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	**1**	**1**	**2**	**1**	**1**
CO2	**1**	**2**	**1**	**2**	**1**
CO3	**2**	**2**	**1**	**2**	**3**
CO4	**1**	**3**	**3**	**3**	**1**
CO5	**1**	**1**	**1**	**-**	**2**

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit I

Introduction to Seismology: Earthquake Phenomena, Types and Causes of Earthquakes, concept of focus, focal depth, epicentre, great Indian earthquakes, intensity and magnitude scales and energy of earthquakes, foreshocks and aftershocks.

Unit II

Theory of elasticity: Elastic rebound theory, Stress and Strain tensors, Elastic constants, Equation of motion and its solution in terms of displacement for an elastic isotropic body. Body waves and surface waves, their characters and passage through the earth, group and phase velocities, dispersion, attenuation, diffraction and scattering of seismic waves, Reflection and refraction of elastic waves, Shadow Zone, Free oscillations of the Earth and interior of the earth. Seismic rays in a spherically stratified earth model, concept of anisotropy.

Unit III

Principles of seismographs: chief types, construction and standardization, damping, Short period, Long period, Broadband seismometers and Strong motion accelerographs, Digital Recorders, Dynamic Range, Global Seismic networks, Seismic arrays and detection of nuclear explosions, Broadband networks and seismic arrays in India. Interpretation of seismograms; Identification and Nomenclature of Phases, Travel time curves, determination of earthquake parameters (epicenter, focal depth, time of origin and magnitude), magnitude scales – Richter, mb, Ms, Mw, CODA, Mwp. Foreshocks, aftershocks and swarms, frequency-magnitude relationship, energy release, intensity scales and isoseismal lines.

Unit IV:

Source Studies: Mechanics of faulting – stress field, rock fracture criteria, Andersonian faulting, stress drop, stress relaxation; earthquake rupture - nucleation, - propagation, - directivity, - speed and - arrest, Single couple and double couple radiation pattern, elastodynamics, Haskell function, seismic moment tensor, focal mechanism and fault plane solutions, Waveform modeling.

Unit V:

Advances in Seismology: Classical geodetic techniques in tectonic studies modern geodetic observation systems to constrain crustal deformation models, volcano geodesy, receiver function, source location as an inverse problem, Green's function, Seismic tomography, Paleoseismology.

Unit VI:

Seismotectonics: Seismic cycle at subduction zones, tsunamigenic earthquakes; induced seismicity; Seismic Zoning and Microzonation, Seismic hazards; Earthquake precursors, recurrence models, prediction, seismic gaps.

References:

- Elementary seismology, C.F. Richter, 1952, W.H. Freeman & Co. Ltd.
- An introduction to the theory of Seismology, K.E. Bullen & B. Bolt, 1985, Cambridge.
- Quantitative Seismology, Vol. I and II, Aki & Richards, 2002, University Science Books.
- The Physics of Earthquakes, HirooKanamori and Emily E Brodsky2, 2004, Reports on Progress in Physics, Institutes of Physics Publishing.
- Modern Global Seismology, Thorne Lay and TerryWallace, 1995, Academic Press.
- Introduction to Seismology, Peter M. Shearer, 1999, Cambridge.
- The Mechanics of Earthquakes and Faulting, Christopher Scholz, 2019, Cambridge.
- The Geology of earthquakes, Robert Yeats and Kerry Sieh, 1996, OUP-USA.
- Induced seismicity, H.K.Gupta and R.K.Chadha, 1995, Birkhuser.
- Introduction to Seismology, Earthquakes and, Seth Stein and Michaell Wysession Earth Structure, 2002, Blackwell Publishing.

24-317-0203	REMOTE SENSING & GIS	Core	Credit 3

No	Outcomes	Bloom's Level
1	Understanding the basic concepts of geospatial technologies	2
2	Understanding of various platforms, sensors and satellites	4
3	Basic concepts of GIS and its applications	2

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	3	2	3	2
CO2	1	3	1	2	1
CO3	1	3	1	3	3

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit I

Basics of remote sensing – Laws of Radiation, Sources of EMR, electromagnetic spectrum – interaction of EMR with atmosphere and Earth Surface. Sensing of EMR – visible, near infrared, thermal and microwave. Spectral signatures for water, land and vegetation

Unit II

Platforms and Sensors & Principles of Photogrammetry; Aircraft Surveys – low and high altitude flying; various types of Sensors- Active and Passive; Resolution - Spatial, spectral, radiometric & temporal. Orbits and platforms for earth observation. Multi spectral scanners (MSS).Satellite characteristics.

Unit III

Satellites – polar and geostationary. Indian satellites – spectral characteristics – present satellites atmospheric and terrestrial studies – data acquisition from satellites. Aerial photos – types, scale, resolution, properties of aerial photos, stereoscopic parallax, relief displacement; Principles of photogrammetry;

Unit IV

Digital image processing - characteristics of remote sensing data, pre-processing, Enhancements (band ratioing, stretching, convolution and rotation, contrast enhancement, thresholding) & classification (Unsupervised and Supervised); Elements of photo and imagery pattern and interpretation, application in Geology.

Unit V

Principles and components of Geographic Information System (GIS), Issues of Spatial and nonspatial data collection, representation and standardization; Data collection; Data Organization (location, attributes, consistency, scale); Vector and Raster data; Metadata; Data Interoperability; Data standardization; Data Classification. Concept of Map Scale, Georectification; Projection and Datum, GIS for Analysis and Modeling of Spatial Phenomena: Overlay, Proximity And Network Analysis.

Unit VI

Remote sensing and GIS application in in various earth science studies and allied topics – structure and tectonics, Lithological mapping, mineral resources, natural hazards and disaster mitigation, groundwater potentials and environmental monitoring; LULC mapping, coastal zone management, Marine Fisheries and wetland management

Unit VII

Hands On sessions on Georeferencing of maps; Digitisation of the maps and creation of Point, Line and Polygon layers by using ARCGIS. Data downloading from satellites and other Geoscience Websites viz. Bhukosh, Google Earth Engine and Identification of Lineaments using Google Tools, SOI and so on. Contouring of works in ArcGIS GPS-Practical applications in the field.

References:

- Burrough, P. A., McDonnel R.A., Lloyd C. D.(2015): Principles of Geographical Information Systems, Oxford University Press.
- Cracknell. A.P (1983): Remote Sensing Applications in Marine Science and Technology, Springer Netherlands

- Kang-Tsung Chang (2013): Introduction to Geographic Information Systems 7th Edition, McGraw- Hill
- Lillesand T., Kiefer J.C(2015): Remote Sensing and Image Interpretation, Wiley
- Remote sensing of atmosphere and oceans, Deepak. A., 1980, Academic Press
- Rafel C Gonzalez and Richard E woods (2018): Digital image processing, Pearson India Education Services, Pvt. Ltd; Noida.
- Rao, D.P (1995): Remote Sensing for Earth Resources, Association of Exploration Geophysicists

24-317-0204	**WELL LOGGING**	**Core**	**Credit 3**

No	Outcomes	Bloom's Level
1	Explain the basic rock and fluid properties that can be measured- porosity, permeability, fluid saturation and resistivity	2
2	Explain the various resistivity logs that helps in calculation of the fluid saturation of the adjacent bed	2
3	Explain the importance of radioactive logs and its techniques for the identification of lithology of the reservoir	3
4	Explain the importance of sonic, nuclear magnetic logging for the identification of porosity of the adjacent bed	3

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	3	1
CO2	2	2	1	1	-
CO3	2	1	1	1	-
CO4	1	2	2	1	-

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit-I

Reservoir characteristics and objectives of well logging. Physical Properties of rocks, porosity, saturation, permeability, conductivity, effect of salinity and temperature on formation of waters. Drilling fluids and its properties. Borehole characteristics, mud filtrate, Invasion, Flushed and Invaded zone, Formation factor and its dependence on porosity and saturation. Anisotropy, Distribution of fluids and resistivities in permeable formations. Archie’s formulae, logging operational field system and its procedure. Classification of logging techniques.

Unit-II

Electrical logging: Spontaneous Potential (SP) logging, origin, static SP, PSP, factors affecting the shape and amplitude of SP curve, Interpretation, Resistivity logging: Principles of normal and lateral logs, Determination of true resistivity. Focused logs-laterology and micrology. Microlaterology, Flushed zone resistivity, mud cake and mud filtrate resistivities. Interpretation of these methods for the determination of porosity, permeability, saturation and various resistivities of the formation. Theory and interpretation of Induction logging, True resistivities, Electromagnetic propagation tool.

Unit-III

Radioactive logging :Basic principles of radioactivity, Instrumentation and logging procedures, Natural Gamma ray logging, Neutron logging, Density logging, Neutron activation logging, Interpretation of radioactive logging, porosity determination.

Unit-IV

Other Miscellaneous Logging Techniques: Principles of sonic logging: Velocity in form media logging procedures and their interpretation, Magnetic logging: Nuclear magnetic logging and their interpretation. Temperature logging, cementation bond logging. Caliper logging, Micro caliper logging perforation sidewall sampling. Dip meter logging.

Unit-V

Departure curves, cross plots for porosity and lithology. Interpretation of well log data: Identification of structural features, identification of lithology, identification of sedimentary features and facies recognition. Applications of the well Logging Methods.

References:

- Formation evaluation, E.J. Lynch, 1962, Harper & Row.
- Handbook of well log analysis, S.J. Pirson, 1963
- The fundamentals of well log interpretation, M.R.J. Wyllie, 1990, Academic Press.
- Schlumberger Log Interpretation Principles /Applications, Schlumberger
- The Geological Interpretation of Well Logs, Malcolm Rider, 1996, Gulf Pub. Co.
- Well Logging for Earth Scientists, Darwin V. Ellis and Julin M Singer, 2007, Springer

24-317-0205	**ELECTRICAL & ELECTROMAGNETIC PROSPECTING**	**Core**	**Credit 3**

No	Outcomes	Bloom's Level
1	Understand the basic principles of the electrical and electromagnetic prospecting	2
2	Experience on the working principle of various electrical and electromagnetic prospecting instruments and their calibrations	3
3	Make capable to analyse various data acquisition steps and survey procedures along with the various data processing and reduction steps in electrical and electromagnetic prospecting	4
4	Understand various principles of interpretation of electrical and electromagnetic data in terms of geological expression	5
5	To be able to generate different electrical and electromagnetic anomaly maps and their interpretation in terms of subsurface geology	5

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	1	1
CO2	3	2	3	1	1
CO3	3	3	3	2	1
CO4	2	3	3	1	1
CO5	3	1	1	1	1

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit-I

Electrical properties of earth material: Resistivities of Rock and minerals, Electric Potentials and electrical conductivities. Introduction to Electrical methods of geophysical prospecting, classification of electrical methods. Principles of Resistivity methods, Instruments for Resistivity methods; Current flow in anisotropic homogeneous earth. Current flow in layered, isotropic earth. Various electrode arrangements and geometrical factors. Resistivity meters, electrodes and field procedures. Resistivity field surveys in different array configurations (Wenner, Schlumberger, dipole-dipole, pole-pole, pole-dipole), Profiling and Sounding techniques, Resistivity imaging, Resistivity Data analysis and Interpretation. Type curves for 2, 3 and 4 layer cases. 1D Forward modeling. 1D inversion. Interpretation. 2D and 3D surveys, pseudo-section. A brief introduction to 2D and 3d Modeling.

Unit-II

Spontaneous Polarization, Origin of potentials-theory, Self potential Field equipments, field procedure, interpretation and application. Brief description of the principle, field procedure and application for the charged body method. Induced Polarization: principle, Source of the IP effects, Membrane and Electrode polarizations, IP field equipments, field procedure, IP in time domain and Frequency domain measurements, interpretation, application.

Unit-III

Maxwell's Equations and Boundary conditions, Principles of EM prospecting. Classification of EM methods. Induction: Telluric method, Geomagnetic Depth Sounding. Magnetotelluric methods: Origin and characteristics of MT fields, Instrumentation, Transverse Electric and Transverse Magnetic Modes. 1D forward modeling. CSAMT. GPR: principle, field procedure, applications. CSEM: principle, field procedure, applications.

Unit-IV

Dip angle measurements, AFMAG and VLF method, fixed transmitter inline and broad side arrays. Phase measurements, Turam, Slingram. Time Domain systems. Airborne electromagnetic surveys- Frequency Domain and Time Domain systems.

Unit-V

Analytic modeling and Scale modeling in electromagnetics. Finite Difference and Finite Element modeling in resistivity and EM methods. Application of electrical and electromagnetic methods in mineral exploration, petroleum exploration and ground water exploration.

References

- Geophysical exploration :Heiland C.A
- An introduction to Geophysical Prospecting, Dobrin, MB.,
- Applied Geophysics Telford W.M et al
- Electrical Methods in Geophysical Prospecting, Keller, G.V.andFrischknecht, F.C.
- D C Electrical sounding, Bhattacharya P.K et al
- Mining Geophysics, Parasnis D.S
- The geo-electricital methods in geophysical exploration MS Zhdanov & GV Keller
- D.C. Geo-electrical sounding: principles and interpretationBhattacharya and Patra
- The application of linear filter theory to the Direct interpretation of geo-electrical resistivity measurements,.Ghosh
- Ground penetrating radar theory and applications, Harry Jol

24-317-0206	ELECTRONICS (PRACTICAL)	Core	Credit 1

No	Outcomes	Bloom's Level
1	Developing self-designing and circuiting capability using Op – Amps	6
2	Measurement using transducers	4
3	Familiarization of digital circuits	2

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	2	-	-
CO2	2	1	2	-	-
CO3	2	1	2	-	-

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Analog experiments:

- ❖ Experiments with Op-Amps: Design and construct inverting, non-inverting, summing, differential, unity gain amplifiers. Calculate the gain and bandwidth
- ❖ Construct instrumentation amplifier and calculate the CMRR, compare CMRR with that of an ordinary Op-Amp
- ❖ Experiments with 555 Timer IC: Design and construct and monostablemultivibrators. Calculate output frequency of Astablemultivibrator. Calculate output pulse width of monostablemultivibrator.

Digital experiments:

- ❖ Construction of simplified logic circuit to implement a given Truth Table, Multiplexers, Demultiplexers, Construction of binary counters, decade counter, seven-segment- LED decoder/driver combination to display number of pulses in decimal form. Basics of A/D and D/A.
- ❖ Transducers and measurements. Calibration and use of various sensors for measurement of parameters like temperature, pressure, light intensity and displacements

24-317-0207	ELECTRICAL & ELECTROMAGNETIC PROSPECTING (PRACTICAL)	Core	Credit 1

No	Outcomes	Bloom's Level
1	Understand the basic principles of electrical prospecting and to be able to review the methods and techniques of electrical prospecting and their classification	2
2	Know the working principle of various electrical prospecting instruments and their calibrations	3
3	Understanding various survey procedures, data acquisition and data processing in electrical surveys	3
4	The ability to understand various principles of interpretation of electrical data in terms of geological expression	4
5	To generate different resistivity anomaly maps and their interpretation in terms of subsurface geology	5

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	1	1
CO2	3	2	3	1	1
CO3	3	3	3	2	1
CO4	2	3	3	1	1
CO5	3	1	1	1	1

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

- Plotting of equipotential traces and current lines for a point source. Measurement of resistivity for rock, soil and fluid samples using four electrode methods
- Recording of vertical electrical sounding data using Schlumberger, Wenner and two electrode configurations and generation of anomaly curves.

- ❖ Field set-up and data acquisition procedure for multi-electrode resistivity survey and Interpretation of field resistivity sounding curves.
- ❖ Recording of electrical resistivity profiling data, their analysis and interpretation
- ❖ Data acquisition and Interpretation of S.P. Anomalies and I.P. Data
- ❖ Data acquisition and generation of pseudo sections for resistivity imaging. Depth of investigation and vertical resolution of field resistivity data
- ❖ Computer-aided interpretation of sounding curve data. Inversion of 2D resistivity imaging data.
- ❖ Near surface Geophysical observations using Electrical and Electromagnetic Methods

24-317-0208	SEISMOLOGY (PRACTICAL)	Core	Credit 1

No	Outcomes	Bloom's Level
1	Basic isoseismal map preparation	4
2	Seismological data analysis	4
3	Computation of a & b values	5
4	Moment tensor estimation & interpretation	5

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	3	3	2
CO2	1	1	3	3	2
CO3	1	1	2	3	1
CO4	1	1	3	3	1

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

- ❖ Preparation of isoseismal maps; finding the origin time using Wadati plot.
- ❖ Seismological data analysis using standard seismological software-identification of phases, location, magnitude.
- ❖ Calculation of a and b values in a seismogenic zone using graphical method and statistical formulae.

- Computations: Finding eigenvalues and eigenvectors of a symmetric tensor; Plotting the Mohr circle for a stress tensor; Moment tensor solutions and focal mechanism; Computing Plate velocities.
- Field visit and hands on training at seismic observatory.

24-317-0209	REMOTE SENSING & GIS (PRACTICAL)	Core	Credit 1

No	Outcomes	Bloom's Level
1	Ability to apply photogrammetry and GIS concepts	3
2	Working knowledge on raster to vector data conversions image processing and corrections	4

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	3	2	-	3
CO2	1	3	3	2	3

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

- Map reading; Watershed delineation; Visual image interpretation, Generation of maps.
- Arial photograph interpretation, Digital Image Processing-Various types of correction, Image classification- supervised and Unsupervised
- Analog to Digital Conversion – Scanning methods, Geo referencing of the maps.
- Digitisation of maps, creation of Point, Line and Polygon layers using Arc GIS.
- DEM Generation; Data Editing-Removal of errors – Overshoot & Undershoot, Snapping Data Collection and Integration, Non-spatial data attachment working with tables; Dissolving and Merging
- Data downloading from satellites and from websites; Clipping, Intersection and Union; Buffering techniques; Spatial and Attribute query and Analysis Contouring and DEM; Advanced Analyses-Network analyses; Layout Generation and report
- Google Earth Engine and Identification of Lineaments using Google Tools.

24-317-0210	STRATIGRAPHY AND INDIAN GEOLOGY	Elective	Credit 3

No	Outcomes	Bloom's Level
1	Understand the stratigraphy and Paleontology encompasses the aspects of the age of the earth through the geologic time	2
2	The knowledge of the concepts in stratigraphy would enable the students to understand the changes that occurred in the history of the earth through chronological arrangement of rocks and relate them to their field observations and also, in understanding the framework of the stratigraphy of India	4
3	Explain the Geology of Kerala and origin of Mineral Resources of Kerala	3

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	1	2	1
CO2	2	1	3	2	1
CO3	1	3	1	1	-

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit-I

Stratification and rock sequence: Stratigraphy, its significance and scope. Principles of stratigraphy. Geological record and its imperfection, missing intervals. Elements of lithostratigraphic, chronostratigraphic and biostatigraphic classifications and their units. Definition and methods of stratigraphic correlation. Palaeogeography and basic principles of palaeogeographic reconstruction. Concept of facies in Stratigraphy.

Unit-II

Precambrian: A brief account of the lithological and structural characteristics of shield areas, with special reference to the Indian peninsula. Proterozoic basins and Stratigraphy of major Indian basins. Palaeozoics and Mesozoics of Indian subcontinent with special reference to marine successions. A brief account of the Evolution of Gondwanaland and Gondwana Stratigraphy of India.

Unit-III

Deccan Traps: Lateral and vertical extents, lithology, age and magnetostratigraphy, Cenozoic: Distribution in India, classification description and correlation of the Palaeogene Neogene formations in the Indian subcontinent. Application of Stratigraphy in the exploration of hydrocarbons.

Unit IV:

Geology and Mineral Resources of Kerala

Introduction, Physiography, Geology and Economic Minerals

References:

- Principles of stratigraphy, Dunbar C. O. & Rodgers J., 1957, John Wiley
- Geology of India and Burma 6th Edition, Krishnan M. S., 2006, CBS Publishers & Distributors
- Geology of india Vol I & II, Ramakrishnan M. and Vaidyanathan R., 2008, GeologicalSociety of India
- Startigraphic Principles and Practice, Weller M. 1959, Harper and Brothers Publishers
- Fundamentals of Historical Geology and Stratigraphy of India, Ravindra Kumar G., 2018, New Age.

24-317-0211	SEQUENCE STRATIGRAPHY	Elective	Credit 2

No	Outcomes	Bloom's Level
1	Recognize and interpret the stratigraphic surfaces and depositional sequences.	4
2	Utilize sequence stratigraphic techniques to examine sedimentary basins.	3
3	Analyze the stratigraphic record and reconstruct depositional environments.	4

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	**3**	**3**	**3**	**-**	**1**
CO2	**3**	**3**	**1**	**-**	**1**
CO3	**3**	**3**	**1**	**1**	**1**

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit-I

Introduction to sequence stratigraphy: Definition and History of sequence stratigraphy, Transgression and Regression, Depositional sequences and their components- System tracts Lowstand system tract, Highstand system tract, Regressive system tract. Concepts of Overlap, offlap, toplap and onlap.Sequence boundaries and bounding surfaces.

Unit-II

High resolution stratigraphy: Stratotypes, Global boundary Stratotype Sections and Points, Code of stratigraphic nomenclature. Eustasy and tectonics. Mean sea level and sea level changes. Cyclic sedimentation, Types of unconformities and their significance.

Unit-III

Sequence stratigraphy in hydrocarbon exploration: Applications of sequence stratigraphy in source rock exploration. Sequence stratigraphic analysis using well logs, seismic data, and outcrop studies.

Unit-IV

Basin characterisation: Basin subsidence and sediment supply. Rates of sedimentary accumulation, Applications of sequence stratigraphy in different geological settings: rift basins, passive margins, foreland basin.

References:

- Octavian, C., (2022) Principles of Sequence Stratigraphy. Elsevier Science.
- Andrew D. M., (2022) Stratigraphy: A Modern Synthesis. Springer International Publishing.
- Emery, D. and Myers, K.J., (1996) Sequence Stratigraphy. Oxford, B.U. Haq., (1995) Sequence Stratigraphy and Depositional Response to Eustatic, Tectonic and Climatic Forcing, Springer.
- Boggs, S., (1995) Principles of Sedimentology and Stratigraphy. Prentice Hall, Englewood Cliffs.

10.3. Semester III

24-317-0301	DIGITAL SIGNAL PROCESSING	Core	Credit 3

No	Outcomes	Bloom's Level
1	Understanding of discrete time signals and systems and its analysis and operations	2
2	Sampling data using filters and its application in geophysics	4
3	Understanding of filter designing	3
4	Different types of transforms	4

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	-	-	2	-	-
CO2	1	-	3	-	-
CO3	1	-	2	-	1
CO4	1	-	2	-	1

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit-I

Signals: Typical discrete-time signals, Type of Signals, Operations on signals like shift, addition, multiplication etc.,

Discrete-Time Systems: , linear time-invariant systems, causal and stable systems, analog signal conditioning, Sampling, Aliasing, sampling rate conversion.

Unit-II

Z-Transform: Properties of the Z-transform, the inverse Z-transform, Analysis of discrete-time systems, Realization of Digital linear systems, Applications of Z-transform to the analysis of Discrete-Time systems.

Review of Fourier Transform: Discrete and Fourier Transform (DFT) , the inverse Discrete Transform (IDFT), DFT properties, Circular convolution, DFT frequency response characteristics, Fast Fourier Transform (FFT), FFT decimation-in-time (DIT) and FFT decimation-in-frequency (DIF) algorithms, FFT algorithm, Fast convolution

Unit-III

Design of Analog and IIR Digital Filters: Analog filter (Butterworth, Chebyshev and elliptic) approximations, Frequency Band Transformations, Bilinear transformations, Low- pass, High-pass, Band-pass and Band-stop digital filter designs, Generalized IIR Digital Filter Transfer function forms, Design procedures, other techniques for designing IIR digital filter, Computer-aided design

Unit-IV

FIR Digital Filter Design: Characteristics of FIR Digital Filters, Properties, the Fourier series method of designing FIR filters, window method, Triangular, Hann, Hamming, Black-man-Harris, Kaiser-Bessel Weighting functions, FIR half-band filters, digital networks for linear-phase FIR digital filters, Computer-aided FIR filter design.

Unit-V

Wavelets: Introduction to wavelet theory and its applications in signal processing. Introduction to adaptive filtering, the Stochastic Wiener Filtering, Deterministic least squares problems.

References:

- Digital Signal Processing, Alan V.Oppenheim, 1988, Prentice-Hall.
- Digital Signal Processing. A System Design Approach, David J. DeFatta, Joseph G. Lucas, William S. Hodgkiss, 1988, Wiley.
- Wavelets and Signal Processing: An application Based Introduction, Hans-Georg Stark, 2005, Springer-Verlag.
- Digital Signal Processing- Principles. Algorithms and Applications, J.G.Proakis and D.G.Manolakis, 2007, Prentice-Hall of India Pvt. Ltd., 2007.
- Digital Signal Processing: A Computer Based Approach, Sanjit K Mitra, 2013, McGraw- Hill.

24-317-0302	SEISMIC PROSPECTING	Core	Credit 3

No	Outcomes	Bloom's Level
1	Understand the principles of seismic prospecting-types of elastic waves and different types of velocity	2
2	Knowledge about the various energy sources and receivers used for land and marine surveys	3
3	Experience the field procedures to conduct the survey both on land and marine and the steps for the initial processing of the datasets	4
4	Understand the various seismic processing steps to be taken to enhance the signal and eliminate the noise	4
5	Familiarise the various interpretation techniques and methodologies	5

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	1	1	1
CO2	3	3	1	1	1
CO3	3	3	3	1	2
CO4	1	1	1	1	2
CO5	1	1	1	1	2

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit I:

Motivation for Seismic Prospecting, Oil Exploration, Mining and Engineering Application, Principles and Physical Basis of Seismic prospecting: Types of Elastic Waves, Expression for wave velocities, Reflection and Refraction of normally and oblique incident rays, Snell's Law, Critical refraction, Reflection and Transmission coefficients, Diffraction, seismic waves attenuation-geometrical spreading, intrinsic attenuation, scattering. Elastic wave velocities of rock, factors affecting the velocities. Different types of velocity.

Unit II:

Geometry of ray paths, refraction and reflection. Horizontal layers and dipping layers, NMO and dip move out. Seismic data acquisition –Energy sources for land and marine surveys-Dynamite, Thumper, Dinoseis, Vibroseis, Land air gun, Pinger, Sparker, Boomer, Airguns, waterguns. Land receivers-Electromagnetic Geophones and its performance, damping coefficient. Marine receivers-hydrophones and streamers. analog and digital recording, dynamic range.

Unit III:

Seismic reflection surveys: Field layout and shooting procedures for land and marine surveys, split spread and end-on spreads, CDP procedures for land and marine surveys stacking charts. 3-D surveys, vertical seismic profiling single channel and multichannel surveys. Refraction surveys, field procedures- fan shooting, broad-side shooting, long refraction profiles., reduction of data, interpretation, marine refraction, sonobuoy surveys, analysis of refraction records, interpretation of reversed and unreversed profiles, delay time methods, masked layers and hidden layers.

Unit IV:

Static and dynamic corrections, velocity determination, preparation of seismic sections, migration analysis of analogue records. Automatic processing of digital seismic data, demultiplexing, TAR, veloctiy analysis, stacking, deconvolution, frequency filtering, AVO analysis, seismic section plotting, display types, picking of events marking, Isochronmaps, Isopach maps, geological interpretation, synthetic seismogram. High resolution reflection seismic soundings, dispersion studies and amplitude analysis.

Unit V:

Application of reflection and refraction methods: Seismic stratigraphy: geological sea level change model. Depositional patterns, seismic sequences, seismic facies, reflection character concepts, exploration for minerals, oil and gas, groundwater engineering surveys. Structural traps and stratigraphic traps:identification of geological structures like anticlines, faults, salt domes etc. Pitfalls in interpretation. Bright spot, seismic attributes, hydrocarbon indicators.

Unit VI:

Ground-Penetrating Radar Introduction, Electromagnetic Theory, Physical properties, EM wave properties, GPR Instrumentation, Modeling of GPR Responses, Survey Design, Data processing, Interpretation, Case Studies and Pit falls.

References:

- Interpretation theory in Applied Geophysics, F.S. Grant and G.F West, 1965,
- Seismic stratigraphy, Robert E Sheriff, 1980, Springer
- Seismic Data Processing Vol I and II, Oz. Yilmaz, 1987, Society of Exploration Geophysics.
- Exploration Seismology, Sheriff & Geldart, 1995, Cambridge.
- Applied Geophysics, Telford W.M., Geldart L.P. and Sherif R.H., 1997, Cambridge.
- Exploration Geophysics, M. Gadallah and R. Fisher,2009, Springer
- Introduction to Geophysical Prospecting, Milton B. Drobrin and Carl H. Savit, 2014, Mc Graw Hill.
- Marine Geophysics, Jones E.J.W., 2016, Wiley.

24-317-0303	OFFSHORE EXPLORATION	Core	Credit 3

No	Outcomes	Bloom's Level
1	Understand the working principle of position fixing in sea, Radio position fixing and satellite position fixing systems	2
2	Comprehend various data acquisition and survey procedures in marine surveys, such as bathymetry, gravity and magnetic etc.	2
3	Be acquainted with various data processing and reduction steps in bathymetric, marine gravity and magnetic surveys.	3
4	Have insight about various principles of offshore mining and drilling techniques and various platforms used for marine exploration and exploitation.	4
5	Understand Law of the sea, EEZ management. Jurisdiction in the sea.	2

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	-	1
CO2	3	3	2	1	1
CO3	3	3	3	1	2
CO4	3	3	1	1	2
CO5	1	1	1	-	1

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit-I

Position fixing at sea: Lunar distance, latitude, longitude. Navigational charts Types of Navigation: Dead reckoning, Piloting Celestial navigation, Radio navigation, Radar navigation, Satellite navigation: Global Positioning System (GPS): Working principle, Satellite signals, Position calculation, Data corrections, GLONASS.

Unit-II

Bathymetry and sea-bed imaging: Introduction to Bathymetry and Seabed imaging, Principle of Sonar system, single beam and multibeam echo sounder. Side scan sonar imaging. Bathymetric charts. Engineering and geological application.

Unit-III

Offshore Mining, Dredging and Drilling: Ocean dredging and mining methods: drilling methods, re-entry problems, Offshore structures: Fixed platform, Floating structures: drill platforms, drill ships, submersible platforms, production platforms, ROVs and underwater servicing. Dredging and other mining techniques. Deep sea mining, Method of extracting nodules and gas hydrates.

Unit-IV

Marine Geophysical Surveys: For oil and gas, Gas Hydrates, Nodules, Glauconite, Phosphorite, Placers etc.

Unit-V

Law of the sea. UN conventions on the law of the sea (UNCLOS). International Tribunal for the law of the sea, EEZ management. Jurisdiction in the seas. Piracy. International seabed authority. Maritime delimitation and dispute settlement. Arctic and Antarctic Ocean research activities.

References

- Geophysical Exploration, C.A. Heiland
- Offshore Exploration, R.K. Verma
- The Sea Vol.3, M.N. Hill
- Ocean sciences, technology & the future International law of the sea, Bake W.T
- Bathymetric navigation and charting, Cohen P.M.

24-317-0304	GROUNDWATER GEOPHYSICS	Core	Credit 3

No	Outcomes	Bloom's Level
1	Understand the concepts of hydrology and groundwater provinces of India	2
2	Familiarize the groundwater recharge methods and management	4
3	Applications of various geophysical methods in groundwater exploration	3

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	-	3	1	1	2
CO2	-	1	1	-	2
CO3	-	3	2	1	2

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit I

Occurrence and distribution of groundwater Origin of water on Earth; global water cycle and budget; vertical distribution of groundwater, residence time concept, geologic formations as aquifers; confined and unconfined aquifers; groundwater table mapping and piezometric nests; porosity, void ratio, effective porosity and representative porosity range; primary and secondary porosities; groundwater zonation; specific retention, specific yield; groundwater basins; springs.

Unit II

Groundwater movement and well hydraulics Groundwater flow concepts; Darcy's Law in isotropic and anisotropic media and validity; water flow rates, direction and water volume in aquifers; permeability and hydraulic conductivity and ranges in representative rocks; Bernoulli equation; determination of hydraulic conductivity in field and laboratory; concept of groundwater flow through dispersion and diffusion; transmissivity and aquifer thickness.

Unit III

Water wells and groundwater levels Unidirectional and radial flow to a well (steady and unsteady); well flow near aquifer boundaries; methods for constructing shallow wells, drilling wells, well completion; testing wells, pumping test, slug tests for confined and unconfined aquifers; fluctuations in groundwater levels; stream flow and groundwater flows; groundwater level fluctuations; land subsidence; impact of global climate change on groundwater. Ground Water Provinces of India. Saline Water Intrusion and Ghybem - Hertzberg relationship.

Unit IV

Groundwater exploration: Surface investigation of groundwater: Electrical resistivity method, seismic, gravity and magnetic methods; interpretation of resistivity data w.r.t. Ground- water exploration, subsurface investigation of groundwater- test drilling, resistivity logging, spontaneous potential logging, radiation logging. Site selection of High Potential Dug, Tube and Bore wells in different terrains by using Geophysical Surveys. Application of satellites in ground-water study.

Unit V

Resource management: estimation of safe yield, artificial recharge, monitoring. Use of satellite mapping and GIS in ground-water management. .

References

- Davis S.M, dWest, 1969, Hydrology, JohnWiley Sons.
- Telford, W. M., Geldart, L. P., & Sheriff, R. E. (2012). Applied geophysics.2ndEdition Cambridge university press.
- Todd, D. K., & Mays, L. W. (2004). Groundwater hydrology.John Wiley & Sons.
- Walton, W. C. (1970). Educational Facilities in Ground-Water Geology and Hydrology in the United States and Canada, 1963. Groundwater, 2(3), 21-25.
- Ward, R. C., & Robinson, M. (1967). Principles of hydrology (No. 551.49/W262). New York: McGraw-Hill.
- Karanth K. R. (1989): Hydrogeology, Tata McGraw Hill Publ.
- Reddy AGS (2020): ATextBook on WaterChemistry. NovaSciencePublishers,Inc,
- Raghunath H. M (1990): Groundwater, Wiley Eastern Ltd.

24-317-0305	**GEOPHYSICAL FIELD WORK (PRACTICAL)**	**Core**	**Credit 1**

No	Outcomes	Bloom's Level
1	Understand the basic principles of surveying, field procedures, handling with Toposheets and GPS	2
2	Acquire knowledge about the principles of gravity, magnetic, electrical resistivity and seismic instruments and their calibrations.	3
3	To be acquainted with various survey procedures, data acquisition, data processing and interpretation of gravity, magnetic, electrical resistivity and seismic surveys.	3
4	To generate different gravity, magnetic, electrical resistivity and seismic sections and their interpretation in terms of subsurface geology.	5

24-317-0306	DIGITAL SIGNAL PROCESSING (PRACTICAL)	Core	Credit 1

No	Outcomes	Bloom's Level
1	Programming using MATLAB which includes coding, matrix operations, function generation	4
2	Digital signal processing methods, Filter designing and Signal generation	4
3	Image processing and characteristic extraction	5
4	Signal manipulation using LabVIEW	4

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	-	2	-	1
CO2	2	-	3	-	-
CO3	2	-	3	-	-
CO4	1	-	1	-	-

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

- ❖ Basics of MATLAB programming (practice sessions): Building matrices, Addressing and assigning elements, Building special matrices, Matrix operations, Equation solving, Plotting, Utility commands, Relational operators, Logical operators, Control flow - for loops, while loops, - if-else-end, switch-case-otherwise-end Precision issues, Additional data types – Strings - Cell arrays – Structures, Input/ Output (I/O), Formatted Input/Output, User defined functions – Local , global, persistent variables- Variable arguments in and out, Plotting 2b - Line style - Multiple plots – Histograms - Creating movies, Introduction to Digital Signal Processing Tool Kit and Simulink.
- ❖ Basics of signals and its operations: Standard digital signal generation and its manipulations, Signal operations, Split an arbitrary signal into even and odd components, Convolution – linear and circular, Correlation – auto and cross correlation of two signals

- Design and Implementation of FIR Filter: the Fourier series method of designing FIR filters, window method, Triangular, Hann, Hamming, Black-man-Harris, Kaiser-Bessel Weighting functions. Design and Implementation of IIR Filter: Low- pass, High-pass, Band-pass and Band-stop digital filter designs
- Signal analysis using FFT: To find the FFT/IDFT of a given signal. Spectrum of a signal using Fast Fourier Transform (FFT). FFT and its Applications.
- Signal manipulation using LabVIEW: Generation of signals, process the signals with various types of filters, spectral analysis and other signal manipulations using LabVIEW

24-317-0307	SEISMIC PROSPECTING (PRACTICAL)	Core	Credit 1

No	Outcomes	Bloom's Level
1	Undertake the calculations of Travel-time and Seismic velocities	4
2	Acquire practical knowledge of Seismic data processing	3
3	Interpretation of the seismic sections	5

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	**1**	**2**	**2**	**3**	**1**
CO2	**2**	**1**	**3**	**2**	**1**
CO3	**2**	**1**	**1**	**1**	**1**

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

- Calculation of Reflection and Transmission coefficients. Calculation of average, interval and RMS velocities
- Calculation of travel times of direct, reflected and refracted seismic waves for 2-layer and 3-layer case and along dipping beds
- Seismic data processing, common midpoint method and stacking, - NMO analysis, stacking, etc.

- Interpretation of seismic data in terms of geological structures.
- Near Surface Geophysical survey using 24 channel seismograph. Field survey using Ground Penetrating Radar.

24-317-0308	GEOLOGICAL FIELD WORK	Core	Credit 1

No	Outcomes	Bloom's Level
1	Proficiency in field techniques like mapping and rock identification.	5
2	Understanding of geological processes and interpretations.	4
3	Application of knowledge in real-world geological exploration	3

24-317-0309	PETROLEUM GEOLOGY AND COAL GEOLOGY	Elective	Credit 3

No	Outcomes	Bloom's Level
1	Understand the origin, characteristics and geological settings of fossil fuels	4
2	Familiarize various exploration techniques for coal and petroleum exploration	3

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	3	1	3	1
CO2	1	3	1	3	3

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit I:

The occurrence of petroleum: surface occurrence, subsurface occurrence. The origin of petroleum: Inorganic and organic origin; Transformation of organic matter into petroleum: bacterial activity, heat and pressure, catalytic reaction, radioactivity.

Unit II:

Reservoir rocks, classification – fragmental reservoir rocks, chemical reservoir rocks, marine and non-marine reservoir rocks; characteristics, relationship between porosity and permeability. Reservoir fluids (water, oil and gas): distribution and characters, Oil field water: physical properties of oil field waters.

Unit III:

Structural traps for oil and gas accumulation: traps caused by folding, faulting and fracturing; Primary and secondary Stratigraphic traps, combination traps, salt domes, cap rock. Migration and accumulation of petroleum: Geologic framework of migration and accumulation, primary and secondary migration

Unit IV: Coal geology

Coal Geology – Formation of Coal, Coalification process, in-situ and transported theories about origin of coal. Microscopic and Megascopic constituents. Macerals and its types. Microlithotype and Lithotype. Impurities in Coal. Different varieties of Coal. Humic and sapropelic coal. Concept of coal maturity and ranks of coal. Thermal maturity indicator – Vitrinite reflectance.

Unit V:

Classification of coal - Peat, lignite, bituminous and anthracite coal. Analysis for the assessment of coal quality - Proximate and ultimate analysis. Spatial and temporal distribution of coal in India – Gondwana and Tertiary coal occurrences.

Unit VI:

Application of gravity, magnetic, seismic and well logging methods for exploration of petroleum.

References:

- Petroleum Geology, North P.K.1985
- Petroleum Formation & Occurrences, Tissot B.P. &Wette D.A.1984
- Elements ofPetroleumGeology, Selley R.C.1998
- Sedimentary Organic matter – Organic facies & palynofacies, R.V. Tyson,1995
- Petroleum in theMarineEnvironment, Petrakis L. & WeisF.T.
- Petroleum Exploration & Exploration practice, B. Sahay1994
- Stach, E., (eds.), 1975, Stach's Textbook of Coal Petrology, Gebruder Borntraeger,
- Thomas, L., 2012, Coal Geology, Wiley India Pvt Ltd, Delhi.
- Sharma N.L. and Ram K.S.V. (1966) Introduction to the geology of Coal and Indian Coal fields. Oriental Publishers

24-317-0310	GEO-STATISTICS	Elective	Credit 2

No	Outcomes	Bloom's Level
1	To carry out the analysis of spatially distributed data, providing insights into spatial patterns, trends, and relationships within a geographical area.	4
2	Understanding the methods which enable the estimation of values at un-sampled locations based on the values observed at sampled locations.	2
3	To be able to analyze the techniques facilitate the creation of spatial maps and visualizations that represent the spatial distribution of variables.	4

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	**-**	**1**	**1**	**2**	**1**
CO2	**1**	**1**	**1**	**1**	**1**
CO3	**-**	**1**	**2**	**3**	**1**

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit I

The nature of geological populations. Kinds of variability of geological data: natural variability, sampling variability, preparation variability and analytical variability. Measures of central tendency: mean, mode and median. Measures of variability: sum of square, variance, standard deviation, skewness, kurtosis.

Unit II

Population distribution: normal, poissan and binomial distribution, population density function. Principles of statistical inferences on the basis of sampling distributions chi-square, t and F distributions, and their use in geology.

References

- "Geostatistics: A Tool for Geographers" by Arun Chatterjee and Harish K. Sharma: This book provides an introduction to geostatistical methods tailored for geographers and researchers working in India.
- "Geostatistics for Environmental Applications: Proceedings of the Workshop on Geostatistics for Environmental Applications, Bangalore, India, 17-21 February 1991" edited by M. D. Prasad and P. K. Sen:
- "Geostatistics for Natural Resources Evaluation" by Pierre Goovaerts Publisher: Oxford University Press Year: 1997

24-317-0311	**MINING AND EXPLORATION GEOLOGY**	**Elective**	**Credit 2**

No	**Outcomes**	**Bloom's Level**
1	Learn the fundamentals of mining and exploration methods	2
2	Being aware of the fundamentals of resource evaluation and estimation	4
3	Analysing how social and environmental factors figure into mining operations	4
4	Examining the industry-emerging trends and sustainable mining techniques	5

CO – PSO Mapping Table:

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	3	2
CO2	1	3	2	1	2
CO3	1	1	1	1	3
CO4	2	3	-	1	3

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit-I

Introduction to Mining Geology: Overview of the mining industry and its significance in the global economy. Historical development and key milestones in mining geology. Important Geophysical, Geochemical, Remote sensing and GIS applications in exploration.

Unit II

Mining Methods and Engineering: Features of a mine. Surface mining techniques: open-pit mining, strip mining. Underground mining methods: room and pillar, longwall, block caving. Mine design, planning, and optimization. Geotechnical considerations in mining operation.

Unit III

Mineral Processing and Metallurgy: Principles of mineral processing: comminution, flotation, gravity separation. Extractive metallurgy techniques for refining ores into marketable products. Environmental considerations in mineral processing.

Unit IV

Environmental impacts of mining activities: habitat destruction, land degradation and soil erosion, water and air pollution, human-wildlife conflict, and the loss of biodiversity. Mine Closure and Reclamation: Planning for mine closure and post-mining land use. Techniques for site rehabilitation and ecosystem restoration.

References

- James P., (2022), Text-Book of Mining Geology for the Use of Mining Students and Miners, Creative Media Partners, LLC.
- Beth T., (2016) Mining Geology: Exploration and Management, Syrawood Publishing House
- Marat A., (2016) Applied Mining Geology, Springer.
- Deshmukh, S.R., (2010) Elements of Mining Technology, Denett & Co.
- Roger, M., (2010) Geological Methods in Mineral Exploration and Mining, Springer Heidelberg Dordrecht London New York.

24-317-0312	**MARINE GEOLOGY**	**Core**	**Credit 3**

No	**Outcomes**	**Bloom's Level**
1	Understand the growth and evolution of ocean basins and the role of plate tectonics	2
2	Ability to describe the geological and geophysical techniques for investigate seabed	4
3	Understand the driving forces behind the natural disasters in marine realm	2

CO – PSO Mapping Table:

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	1	2	3	2	2
CO2	3	3	2	1	1
CO3	1	1	1	2	3

Note: Correlations Levels: 1 = Low, 2 = Medium, 3 = High, "-" = No correlation.

Syllabus:

Unit I:

History of Marine Geology, Scope and Applications of Marine Geological Investigations. Oceanic expeditions: Challenger expedition, Deep Sea drilling Project, Ocean drilling Programme, Joint Global Flux Studies (JGOFS), Integrated Ocean Drilling Programme (IODP). Sea floor sampling techniques and devices – snappers, grabs, coring divices, dredging, underwater photography, diving.

Unit II:

Ocean Floor topography-- Continental margins: continental shelf and slope, its origin, continental rise; Submarine canyon and their origin, Oceanic ridges: Ridges, fracture zones; Ocean basins: Abyssal plains, Abyssal hills, Seamounts and guyots, Deep sea channels, submarine trenches and its origin, fjords. Topography of the Indian Ocean floor with special reference to the Bay of Bengal and the Arabian sea

Unit III:

Coral reefs – their types and theory of atoll formation, Sea level changes, causes and evidences of sea level changes,Submarine volcanism, Tsunamis – causes and effects, turbidity currents

Unit IV:

Evolution of Oceans: Structure and evolution of Pacific, Atlantic and Indian Oceans, Red Sea and Mediterranean Sea. Recent developments in the theory of seafloor spreading provide a framework for consideration of the concepts of north south reversals in the direction of the geomagnetic field. Use of magnetic reversals to determine the rate of seafloor spreading.

Unit V:

Marine sediments their classes, sources and transportation, deep sea sediments, brown clay, oozes, their distribution and age, sediments of Indian Ocean floor

References:

- Marine Geology., J.P.Kennet
- The earth beneath the sea, Shepard F.P.

- Submarine Geology, Shepard F.P.
- The Ocean floor, Hams petterson
- Plate Tectonics and crustal evolution, Condia K.C.
- Petrology of the ocean floor, R.Hekinin
- Geotectonics, Belonssov V.V
- Geology of Continental Margins, C.A.Burk&C.L.Drake
- Sea levels, land levels and tide gages, Emery & Aubrey
- Submarine Geology and Geophysics, E.F.Wittard&. Bradshaw R.

10.4. Semester IV

24-317-0401	**PROJECT WORK, PRESENTATION AND VIVA VOCE**	**Core**	**Credit 16**
24-317-0402	**MOOC COURSE*** **	**Elective**	**Credit 03**

***It is mandatory for the students to register for a suitable MOOC (as recommended by Department Council from time to time), available in the SWAYAM platform (www.swayam.gov.in). **The students can avail the courses at any time during the first three semesters, based on the availability of suitable courses at www.swayam.gov.in and should procure the required credits for MOOC before completion of the fourth semester**. Grading of MOOC will be decided by the Department Council and University based on the results obtained from www.swayam.gov.in