KANNUR UNIVERSITY
(Abstract)

MSc Geology programme - under Credit Based Semester System in Affiliated Colleges - Revised Scheme, Syllabus & Model Question Papers - implemented with effect from ***2014 admission - Orders Issued.***

ACADEMIC BRANCH

No. Acad/C2/ 8837/2014 **Dated, Civil Station P.O, 31- 07-2014**

Read: 1.U.O No. Acad/C1/11460/2013 dated 12-03-2014
2. Minutes of the meeting of the Board of Studies in Geology (Cd) held on 26.09.2013
3. Minutes of the meeting of the Faculty of Science held on 25-03-2014
4. Letter dated 10/07/2014 from the Chairperson, BOS in Geology (Cd)

ORDER

1. The Revised Regulations for PG Programmes under Credit based Semester System (CBSS) were implemented in this University with effect from 2014 admission as per paper read (1) above.

2. As per paper read (2) above the Board of Studies in Geology (Cd) finalized the Scheme, Syllabus & model Question Papers of MSc Geology programme to be implemented with effect from 2014 admission.

3. As per read (3) above the Faculty of Science held on 25-03-2014 approved Scheme, syllabus & model question papers of MSc Geology programme to be implemented with effect from 2014 admission.

4. The Chairperson, Board of Studies in Geology (Cd) vide paper read (4) above has submitted the finalized copy of Scheme, syllabus & Model question papers of MSc Geology programme for implementation with effect from 2014 admission.

5. The Vice Chancellor, after examining the matter in detail, and in exercise of the powers of the Academic Council as per section 11(1) of Kannur University Act 1996 and all other enabling provisions read together with, has accorded sanction to implement the revised scheme, syllabus & model question papers of MSc Geology Programme with effect from 2014 admission.

6. Orders, are therefore issued implementing the revised scheme, syllabus & model question papers of MSc Geology programme under CBSS with effect from 2014 admission subject to report to Academic Council

7. Implemented revised Scheme, Syllabus & Model Question Papers are appended.

Sd/-
DEPUTY REGISTRAR (ACADEMIC)
FOR REGISTRAR

To:

1. The Principals of Affiliated Colleges offering M.Sc Geology Programme
2. The Examination Branch (through PA to CE)

Contd.....2

Copy To:

1. The Chairperson, BOS Geology (Cd)
2. PS to VC/PA to PVC/PA to Registrar
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Section Officer

KANNUR UNIVERSITY
KANNUR
PIN-670567
Date
MANGATTUPARA

❖ ***For more details log on to www.kannur university.ac.in***

01.03.17

KANNUR UNIVERSITY

POSTGRADUATE PROGRAMME

UNDER CREDIT BASED SEMESTER SYSTEM

(M.Sc. DEGREE COURSE)

in

GEOLOGY

2014 Admission onwards

SYLLABUS

Prepared by

BOARD OF STUDIES IN GEOLOGY (COMBINED)

2014

Under the financial support of

KERALA STATE HIGHER EDUCATION COUNCIL

MASTER OF SCIENCE IN GEOLOGY (MSc)

Aims and Objectives

- To offer the candidate a Master of Science degree in Geology which will enable the graduate to either register for higher degrees or be employed in areas where graduate degree in Geology is required.
- The subject geology is unique in contrast with other science Post – graduate programmes in that it has multidisciplinary nature and it is associated with Zoology, Botany, Physics, Chemistry, Geography, Mathematics, Computer science, etc. besides engineering subjects like Civil and Mining engineering.
- The present M.Sc. Programme in Geology under Credit Based Semester System has been so meticulously designed as to suit the changing needs of post- graduates in geology by enabling them to compete with others and excel in National Level Examinations like Geologists Examinations, IIT Entrance, UGC/CSIR- NET, etc. The programme contents have been planned in such a way to have a strong foundation in every branch of geology, to impart up to date knowledge in Geomorphology, Remote Sensing, Crystallography, Mineralogy, Geostatistics, Geoinformatics, Marine Geology, Atmospheric science, Structural Geology, Engineering Geology, Quaternary Geology, Sedimentology, Exploration Geology, Geophysics, Igneous and Metamorpic Petrology, Stratigraphy , Palaeontology , Economic Geology, Mining Geology, Hydrogeology, Environmental Geology ,Coal and Petroleum Geology etc.
- **Placement Opportunities :**

  Post – graduates in Geology with good academic record are employed as Junior Geologists in Geological Survey of India (GSI)and Junior Hydrogeologists in Central Ground Water Board (CGWB), Geologist in Oil & Natural Gas Corporation (ONGC), Scientists in Atomic Mineral Division(AMD) , Indian Space Research organization(ISRO),Center for Earth Science Studies(CESS),Centre for Water Resources Development and Management(CWRDM),National Institute of Hydrology(NIH), National Institute of Oceanography(NIO). Assistant Professors in Universities, affiliated Colleges and IITs, Assistant Geologists in State Departments of Mining& Geology, Geological Assistants in

State Ground Water Board, with B.Ed. as Junior Lecturers in the State Higher Secondary Schools, Senior/Junior Research Fellows in University Grants Commission / Council for Scientific and Industrial Research projects, Department of space and at its various centers, Regional Remote Sensing Centres, State Remote Sensing Application Centres, National Remote Sensing centres ,Defence Terrain Research Laboratory, All India soil and Land use Survey, Atomic Mineral Division, National Bureau of Soil Survey & Land use planning, Town and Country Planning, Remote Sensing Laboratories of various Universities, Companies engaged in GIS and its application studies. etc.

- **Admission Requirements**

  A pass in B.Sc. Degree Geology/Water Resource Management as core course with Chemistry/ Physics/ Mathematics/ Statistics/ Remote sensing (any two) as complementary courses

- **Duration of Curriculum**

  The curriculum shall be offered in four semesters within a period of two academic years.

KANNUR UNIVERSITY

MSc. GEOLOGY DEGREE PROGRAMME UNDER CREDIT BASED SEMESTER SYSTEM (CBSS-PG)
(WITH EFFECT FROM 2014 ADMISSIONS)

PROGRAMME STRUCTURE AND SCHEME OF EXAMINATION

Sem	Course code	Title of the course	Exam duration	Hours /week	Total hours	credit	Marks		
							internal	external	total
I	GEO1C01	Geomorphology & remote sensing	3h	5	90	4	12	48	60
	GEO1C02	Crystallography & Mineralogy	3h	6	108	4	12	48	60
	GEO1C03	Geostatistics& Geoinformatics	3h	5	90	4	12	48	60
	GEO1C04	Marine Geology& atmospheric science	3h	5	90	4	12	48	60
	Practical @	Geomorphology Remote Sensing Crystallography and Mineralogy	0	4	72	0	0	0	0
II	GEO2C05	Structural Geology and Engineering Geology	3h	7	126	4	12	48	60
	GEO2C06	Quaternary Geology and Sedimentology	3h	7	126	4	12	48	60
	GEO2E01 or GEO2E02 or GEO2E03	Elective I	3h	7	126	4	12	48	60
	GEO2P01	Geomorphology Remote Sensing Crystallography and Mineralogy	4h	0	0	4	20	80	100
	GEO2P02	Sedimentology and Structural Geology	4h	4	72	4	20	80	100

III	GEO3C 07	Igneous and Metamorphic Petrology	3h	5	90	4	12	48	60
	GEO3C 08	Stratigraphy and Palaeontology	3h	5	90	4	12	48	60
	GEO3C 09	Geochemistry and Isotope Geology	3h	5	90	4	12	48	60
	GEO3 E04 or GEO3E05 or GEO3E06	Elective II	3h	4	72	4	12	48	60
	GEO3C 10	Field Mapping *	0	2	36	2	60	0	60
	Practical @	Igneous Petrology and Metamorphic Petrology , Palaeontology and Geochemistry	0	4	72	0	0	0	0
IV	GEO4C 11	Economic Geology and Mining Geology	3h	6	108	4	12	48	60
	GEO4C 12	Hydrogeology	3h	5	90	4	12	48	60
	GEO4 E07 or GEO4E08 or GEO4E09	Elective III	3h	5	90	4	12	48	60
	GEO4P 03	Igneous and Metamorphic Petrology Palaeontology and Geochemistry	4h	0	0	4	20	80	100
	GEO4P 04	Economic Geology and Hydrogeology	4h	4	72	4	20	80	100
	GEO4 (Pr)	Project/dissertation **	0	5	90	4	30	120	150
	GEO4C 13	Viva Voce	-	0	0	2	0	50	50
Total						80	338	1162	1500

*Students will be on deputation for Field Mapping Programme continuously for 35 hours (ie,7 working days) at the end of III Semester.

**Students will be on deputation for dissertation work continuously for 90 hours (ie, 18 working days) at the end of IV Semester.

Hours and credit distribution for MSc. Geology Programme

Semester	No. of theory courses	No of practicals	Theory		Practicals		Field mapping		Project		Viva		Total hours	Total credits
			Hrs	C	Hrs	C	Hrs	C	Hrs	C	Hrs	C		
I	4	1	21	16	4	0	0	0	0	0	0	0	25	16
II	3	2	21	12	4	4+4	0	0	0	0	0	0	25	20
III	4	1	I9	16	4	0	2	2	0	0	0	0	25	18
IV	3	2	16	12	4	4+4	0	0	5	4	0	2	25	26

Total credits: **80**

MSc.GEOLOGY PROGRAMME- ELECTIVE COURSES

Sl.no.	Course code	Title of the course
1	GEO2E01	Exploration Geology and Geophysics
2	GEO2E02	Oceanography
3	GEO2E03	Geotectonics
4	GEO3E04	Environmental Geology
5	GEO3E05	Planetary Geology
6	GEO3E06	Geochronology
7	GEO4E07	Coal and Petroleum Geology
8	GEO4E08	Field Geology
9	GEO4E09	Industrial Geology

SCHEME OF EVALUATION IN M.Sc. GEOLOGY PROGRAMME UNDER CREDIT BASED SEMESTER SYSTEM (CBSS-PG) WITH EFFECT FROM2014 ADMISSION

The scheme of evaluation in M.Sc Geology Programme under Credit Based Semester System 2014 shall contain 2 parts.

1) Continuous Assessment(CA) and
2) End Semester Evaluation(ESE)

20% marks shall be given to CA and the remaining 80% to ESE. The ratio of marks between internal and external is 1:4 excluding field mapping and viva voce. Both internal and external evaluation shall be carried out using marks with corresponding grades and grade points in 7 points relative grading system.

CONTINOUS ASSESSMENT (CA) THEORY COURSE

Continuous assessment for theory course shall be based on predetermined transparent system involving periodic written test, assignments, seminars and attendance.

The percentage of marks assigned to various components for internal evaluation is as follows.

	Components	**% of internal marks**
I	Two test papers	40
Ii	Assignments	20
Iii	Seminars	20
Iv	Attendance	20

1. **Test Papers:** For each course there shall be at least two class tests during a semester.
2. **Assignments:** Each student shall be required to do 2 assignments for each course. The teacher shall define the expected quality of an assignment in terms of structure, content, presentation etc. and inform the same to the students. Punctuality in submission is to be considered.
3. **Seminar:** Every student shall deliver one seminar as an internal component for every course and must be evaluated by the respective course teacher in terms of structure , content, presentation and interactions. The soft and hard copies of the seminar report are to be submitted to the teacher in charge.
4. **Attendance:** Attendance of each course will be evaluated (internally) as below.

Attendance	**% of marks for attendance**
Above 90% attendance	100
85 to 89%	80
80 to 84%	60
76 to 79%	40
75%	20

The following table illustrates how marks are consolidated for Continuous evaluation(CE) Theory Course.

Reg. No	**Test paper Max. Mark 4.8**	**Assignment Max. Mark 2.4**	**Seminar Max. Mark 2.4**	**Attendance Max. Mark 2.4**	**Total Max. Mark 12**

CONTINUOUS ASSESSMENT (CA) Field mapping

There shall be a Field mapping programme for all students carried out under the supervision of a teacher to understand the geology of an area and prepare a geological map and report. The geological map and report should be submitted for internal assessment to the department. The continuous evaluation of field mapping can be done by teachers who guided the students in the field. Assessment of different components of field mapping and percentage of marks given to each component shall be as follows.

Sl.no	Components	% of marks
1.	Involvement in field mapping	25
2.	Involvement in report writing & Preparation of geological map	25
3.	Presentation & Viva voce	50

The following table shows how marks are consolidated for CE field mapping

Register no.	Components			Total marks
	1 Max.Mark:15	2 Max. Mark 15	3 Max. Mark 30	Max. Mark:60

CONTINUOUS ASSESSMENT PRACTICAL

Continuous assessment for practical shall be based on tests, lab skills, record/viva and attendance.

The percentage of marks assigned to various components for internal evaluation is as follows.

Sl. No.	Components	% of internal marks
1	2 test papers	40
2	Lab skills	20
3	Record / viva	20
4	Attendance	20

The consolidation of marks (CA) practical is as follows.

	Test paper Max. Mark 4	Lab skills Max. Mark 2	Record/viva Max. Mark 2	Attendance Max. Mark 2	Total Max. Mark 10
Reg. No.					

The maximum internal mark for each practical course shall be 20 and out of this 10 mark is for Practical record.

CONTINUOUS ASSESSMENT PROJECT WORK/ DISSERTATION:

Supervising teacher will assess the project and award internal marks. Continuous Assessment of different components of project/dissertation may be taken as below.

Components	% of internal marks	Maximum marks
Punctuality	20	6
Use of Data	20	6
Scheme / Organization of Report	40	12
Viva- Voce	20	6
Total	100	30

END SEMESTER EVALUATION (ESE):

The end semester Examination in theory courses is to be conducted by the University with question papers set by external experts. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation. There shall be double valuation system of answer books. The average of two valuations shall be taken in to account. If there is a variation of more

than 10 % of maximum marks, the answer books shall be valued by a third examiner. The final marks to be awarded shall be the average of the nearest two out of three awarded by the examiners. The maximum marks(ESE) for each theory course shall be 48.

End semester Evaluation in practical courses shall be conducted and evaluated by two examiners – one internal and one external. Duration of practical external examinations shall be 4 hours and maximum mark (ESE) for each practical course shall be 80.

End Semester Evaluation of project work/Dissertation: The ESE of the project work/ dissertation shall be conducted by external examiners appointed by the University.

ESE of different components of project may be taken as below.

Component	% of external marks	Maximum marks
Relevance of the topic	5	6
Statement of objectives	10	12
Methodology/Reference /Bibliography	15	18
Presentation of facts/figures/language style/diagrams etc.	20	24
Quality of Analysis/ Use of Statistical tools	15	18
Findings and Recommendations	10	12
Viva –Voce	25	30
Total	100	120

End Semester Evaluation Viva Voce:
A comprehensive Viva Voce (external) examination on the entire course contents shall be conducted at the end of the last semester for which the maximum marks shall be 50.

Kannur
30.01.2014

Prof.K.Sreemathikutty,
Chairman,
Board of Studies in Geology (Cd)

Marks: External (ESE): 48 **Hrs/week: 5; Total Hrs: 90; Credits: 4**
Internal (CE): 12

GEO 1C 01- GEOMORPHOLOGY & REMOTE SENSING

GEOMORPHOLOGY

MODULE 1

Fundamental concepts in geomorphology: History of the development of geomorphic ideas—Ancient and modern. Different models in the Evolution of landscape: Davis, Penck, King, Gilbert and Hack--Peneplain and Pediplain concepts.

Analysis of geomorphic agents and processes: gradational processes—climatic influences upon geomorphic processes. Evolution of hill slopes: slope elements and parameters—role of water, vegetation and climate on slopes.

Influence of climate and structure on geomorphic processes and landforms. **(12 hours)**

MODULE 2

Morphometric analysis of drainage basins: Morphometric elements and parameters—laws of drainage composition, drainage density, stream frequency, basin shape, stream hydraulics—stream ordering—long profile and transverse profiles—hypsometry. Fluvial geomorphology: Fundamental concepts—base level—relations between channel width, depth and current velocity, sediment transport and erosion—types of load and modes of transportation—competence and capacity—concept of grade, meandering and braided rivers—fluvial deposits, erosional and depositional landforms. Concept of rejuvenation and interruptions in the cycle of erosion. **(12 hours)**

MODULE 3

Coastal geomorphology: Definition of coastal zone—coastal processes: erosion, transportation and deposition by waves, tides and currents—reflection, refraction and breaking of waves—long shore drift and related landforms—coastal submergence and emergence. Critical study of coastal classification. Seal level changes. Shoreline processes and associated landforms--coastal dynamics. **(10 hours)**

MODULE 4

Geomagnetism: Palaeo-magnetism--Polarity Reversals—Polar Wandering. Thermal history of the Earth. Tectonic Geomorphology: -Plate Tectonics-Seismo-tectonics-Kinematics of relative movements of plates--processes at accreting and consuming plate boundaries. **(10 hours)**

REMOTE SENSING

MODULE 5

Basic principles of remote sensing: Definition and components, Electromagnetic Radiation-Black body radiation-Spectral reflectance of land covers. Atmospheric windows. Platforms and sensors—Active and Passive Sensors. Data acquisition and format. Resolution- spatial, temporal, spectral, radiometric. Satellite Remote Sensing: orbital characteristics of remote sensing satellites. Satellite missions: LANDSAT, SPOT, IRS and their applications. **(12 hours)**

MODULE 6

Aerial photography–principles and procedures--types of aerial photographs and photo characters—geometrical properties: scale, parallax, relief displacement and height—Mosaics—Stereoscopy, Pocket and Mirror Stereoscopes.

Aerial photo interpretation: relief and tone, lineaments, structure and geology. Application of aerial photos in photogrammetry. **(12 hours)**

MODULE 7

Multi Spectral Scanners (MSS) and recognition of spectral patterns. Microwave Remote Sensing: SLAR system, terrain characteristics influencing the RADAR return. Interpretation of SLAR data. Thermal Remote sensing: Thermal Radiometers and Scanners--Collection and interpretation of thermographic data. Introduction to hyperspectral remote sensing. **(12 hours)**

MODULE 8

Interpretation and Geological Application of Satellite Remote Sensing data: visual and digital. Basic concepts of Digital image processing. Use of satellite data in Geomorphology-fluvial and coastal landforms, lithology, structure, lineaments, groundwater exploration, monitoring of the environment and natural hazards, landuse, forestry, agriculture, mineral prospecting. **(10 hours)**

Marks: External (ESE): 48
Internal (CE): 12 **Hrs/week: 6; Total Hrs: 108; Credits: 4**

GEO 1C 02- CRYTALLOGRAPHY AND MINERALOGY

MODULE 1
Crystallography: Crystalline, amorphous state and the concept of symmetry of crystals. Zone and Zone symbols, Axial ratio of all crystal systems. Napier's rule and its application in crystallography.

(10 hours)

MODULE 2
Crystal projections: Spherical, Stereographic and Gnomonic projections. Application of stereographic projections in crystallography. Principles of X-ray study in Crystallography and Mineralogy.

(14 hours)

MODULE 3
Refractive Index and Birefringence. Interference colours, Optical accessories: Unit retardation plate, quartz wedge, mica plate, Berek compensator, Biquartz wedge and Bertrand ocular. Wave surface and indicatrices. Dichroism and Plechroism.

(14 hours)

MODULE 4
Conoscopic study and Interference Figures- Uniaxial and Biaxial. Optic Axial Angle and determination by Mallard's method. Optic Sign and determination. Optic Orientation, Extinction and Extinction Angle, Optic anomalies. Dispersion and dispersion types.

(16 hours)

MODULE 5
4-axis Universal Stage: basic principles--adjustment of the Universal Stage and the use of the Wulff's Net. Method of determining the following: Anorthite content and Twin laws of plagioclase feldspars.

(16 hours)

MODULE 6
Clay mineralogy: Characterization, classification and structure of clay minerals. Clay mineral identification by X-rays and DTA. Geochemistry and genesis of clays. Different methods of clay mineral separation

(10 hours)

MODULE 7
Metamictisation, fracturing, discoloration and pleochroic haloes.
Structure, physical, chemical and optical properties, paragenesis and association of the minerals of the following groups: Olivine, Epidote, Garnet, alumino silicates.

(14 hours)

MODULE 8
Structure, physical, chemical and optical properties, paragenesis and association of the minerals of the following groups: Pyroxenes, Amphiboles, Micas, Zeolites, Feldspars and Feldspathoids.

(14 hours)

Marks: External (ESE): 48
Internal (CE): 12 **Hrs/week: 5; Total Hrs: 90; Credits: 4**

GEO 1C 03 GEOSTATISTICS & GEOINFORMATICS

GEOSTATISTICS

MODULE 1

Measures of location and dispersion: Measures of central tendency: Arithmetic Mean, Geometric Mean, Harmonic Mean, Median, Mode, Quartiles. Measures of dispersions: absolute and relative measures, Range, Mean Deviation, Standard Deviation, Variance, Coefficient of Variation, Skewness and Kurtosis.

Statistical surveys: Sampling and census. Important methods of sampling--simple, random, systematic, hierarchical and stratified sampling. Correlation and Regression. Least squares analysis. Multiple and partial correlations.

(12 hours)

MODULE 2

Elements of Probability theory: random experiments, sample space, events, probability of events, addition and multiplication theorems. Random variables, expectation and variance of random variables. Basic distributions: Binomial, Poisson and Normal. Sampling distributions: t, F and Chi-square.

(10 hours)

MODULE 3

Tests of Significance: basic concepts of statistical inference and standard error. Large sample tests and small sample tests: test for population mean(s), variance(s) (one and two samples) F-test. Testing the significance of a correlation coefficient. Contingency tables and testing the independence of attributes. Analysis of variance: One way and two way classification.

(12 hours)

MODULE 4

Matrix theory and numerical mathematics: Operation on matrices--addition, multiplication, transposition and inversion. Determinants – solving simultaneous equations by matrices.

Eigen values and Eigen vectors. Elementary ideas of interpolation and numerical integration.

Multivariable Data Analysis – I: Curve fitting by method of Least Squares, Multiple Correlation and Multiple Regression Analysis, Time Series Analysis, Multivariate Data Analysis.

(10 hours)

GEOINFORMATICS

MODULE 5

Map projection: Basic geodesy - Geoid/Datum/Ellipsoid - Coordinate systems - Scale factor - Distortion on map – projections - Classification of map projections - Polyconic, LCC, Mercator. UTM projections - Map projection transformation – Surveying – Total Station – EDM – LIDAR.

(12 hours)

MODULE 6

GPS: Satellite constellation - GPS signals and data - GPS receivers - Single point positioning - Measuring distance and timing - GPS accuracy - Error corrections - Differential GPS - Glonass and Galileo systems - Applications of GPS - Carrying out a GPS survey

(10 hours)

MODULE 7

Geographic data: Spatial and non-spatial data - Vector and raster data models - Vector and raster data structures - Data compression - Choice between raster and vector - Data transformations - Data sources & data input - Linking spatial and non-spatial data - Errors and quality control - Data storage - Data formats - Database concepts - Database management in GIS- Web GIS - 3DGIS - Object Oriented GIS - Mobile GIS

(10 hours)

MODULE 8

Spatial Analysis **–** Geo-statistical analysis - Proximity analysis (buffering) - Overlay analysis – density analysis - Network analysis - Multi-criteria analysis - Site suitability analysis - Nearest neighbour analysis - Thiessen polygons - Surface mapping - Interpolation (including TIN) **-** Digital elevation model (DEM) - Terrain reclassification – Slope, aspect, angle of incidence. - Visibility (viewshed) analysis - Spatial and non-spatial query.

(14 hours)

Marks: External (ESE): 48
Internal (CE): 12 **Hrs/week: 5; Total Hrs: 90; Credits: 4**

GEO 1C 04 -MARINE GEOLOGY & ATMOSPHERIC SCIENCES

MARINE GEOLOGY

MODULE 1
Ocean floor: Morphologic and tectonic domains. Bathymetric provinces--Submarine Canyons, Mid-Ocean ridges and Trenches. Morphologic and tectonic domains of Indian Ocean.
Physiochemical characteristics and chemistry of sea water: temperature, salinity, density, light transmission, sound transmission in sea water. Gases in sea water. Role of carbon dioxide in keeping the pH of sea water. Instruments used in the study of sea water. Formation of sea ice- Gas hydrates. **(12 hours)**

MODULE 2
Offshore exploration techniques: Instruments and measurements—Position fixing systems—GPS-IRNSS. Tools for studying ocean water—sampling devices—Grabs, dredgers, Corers, Sediment traps, Water Samplers, etc. – various platforms for ocean studies. Tools for studying the ocean floor—Echo-sounding methods—Sidescan Sonar—Current meters—SCUBA diving—submersibles. Ocean floor drilling--JOIDES. Instruments and the application of satellite data in ocean studies. **(12 hours)**

MODULE 3
Marine sediments: Distribution and geochronology of marine sediments. Eustatic changes of sea level and its effects. Carbonate Compensation Depth (CCD). Turbidity currents and turbidites. World ocean circulation patterns—role of ocean in deciding global climate—ocean water masses. **(10 hours)**

MODULE 4
Origin and Age of ocean basins and plate tectonics- East African rift valley system- Origin of Indian Ocean, Arabian Sea and Bengal Sea-Closure of Ocean basin- Tethys Sea and Rise of Himalayas. Palaeooceanography --Sea water and basalt interaction- hydrothermal vents—vent biota and chemosynthesis--Law of the Seas-UNCLOS,EEZ—coastal zone environment and its protection—CRZ Act and CZM plans.
Mineral resources of the ocean basins, factors controlling their distribution. Origin and distribution of polymetallic nodules. Factors of marine pollution and its controls- Satellite Oceanography- instruments used-properties studied-Oceansat Series. **(12 hours)**

ATMOSPHERIC SCIENCES

MODULE 5
Atmosphere; Composition and its internal structure. Classification based on temperature and chemistry. Solar energy, Insolation. Latitudinal zones. Anthropogenic factors on the radiation balance--Heat flow mechanisms--Global distribution of air temperatures--earth and sun relationship. **(10 hours)**

MODULE 6
Atmospheric circulation--Barometric pressures and winds. Coriolis Effect and geostrophic winds—meridional circulation. Global patterns of circulation--tropical easterlies, westerlies, polar easterlies. Jet streams. **(10 hours)**

MODULE 7
Climate and climatic changes—factors influencing climate—interaction of the atmosphere, ocean sphere, biosphere, lithosphere and cryosphere--Cloud classification. Precipitation process. Artificial precipitation--Monsoon system. Cyclones and anticyclones. **(14 hours)**

MODULE 8
Ozone layer: Ozone depletion. Ozone hole. Global Warming and Green House Effect—its consequences. Aerosols in atmosphere. Present status and statutes in the protection of global environment. Role of UN, developed and developing countries—world Summits and the agreements. Kyoto Protocol. **(10 hours)**

Marks: External (ESE): 48 **Hrs/week: 7; Total Hrs: 126; Credits: 4**
Internal (CE): 12

GEO 2C 05 - STRUCTURAL GEOLOGY & ENGINEERING GEOLOGY

STRUCTURAL GEOLOGY

MODULE 1

Rock Deformation: Concept of Stress and Strain. Stress-strain relationship of Elastic, Plastic and viscous materials. Behaviour of minerals and rocks and minerals under deformation conditions. Stress-strain ellipsoid. Deformation in single crystals. Principles of geological mapping and map reading. Orientation of structures. Top and bottom criteria. Geological cross-sections. Graphical representation of orientation data: Histograms, Rose diagrams, spherical projections. **(14 hours)**

MODULE 2

Folds: Classification of folds based on various parameters- geometry, genesis and style. Fold classification by Donath and Parker: Cylindroidal, non-cylindroidal and conical folds. Superposed folds and interference patterns. Canoe folds and inverted canoe folds. Minor/Drag folds and their use in determining the major fold structures--Pumpelley's rule. Mechanics of folding. Recognition of folds in the field.

Faults: Terminology and classification—genetic and geometric—causes and mechanism of faulting. Recognition of faults in the field. Fractures: terminology and classification—tension fractures, shear fractures. Stress ellipsoids and strain ellipsoids and their relation to fractures. **(18 hours)**

MODULE 3

Tectonites: Classification, tectonic fabric—Foliation: classification and origin-geometric relationship of cleavage to folding. Foliation as an aid in determining major structures. Lineation: types, classification and origin—significance in interpretation of tectonic history.

Shear zones: Characteristics and types-brittle, ductile and brittle-ductile shear zones. Shear-sense indicators and shear fabrics. Shear zone rocks - Mylonites and fragmental rocks produced by shearing. **(18 hours)**

MODULE 4

Concept of Structural analysis: principles—structural co-ordinates of Sander. Fundamentals of Kinematic, dynamic and geometric analysis—geometric analysis of folds and lineations—Stereographic and Equal area projections—π and β diagrams.

Rock fabrics: Microfabric and petrofabric analysis. Symmetry concept in fabric analysis. Petrofabric diagrams.
Universal stage and fabric analysis. **(16 hours)**

ENGINEERING GEOLOGY

MODULE 5

Role of Geology in Civil Engineering: Rock as a construction material- igneous, sedimentary, metamorphic rocks. Engineering properties of construction materials. Influence of geological factors on engineering properties. Structural discontinuities and nature of fillings. Rock-water interaction.
Soils, classification and Engineering properties. **(12 hours)**

MODULE 6

Stages of geotechnical investigation for river valley projects.

Dams: types of dams--general criteria for selection of dam sites—foundation rocks—topography, availability of construction materials. Grouting—abutment and reservoir problems—environmental impact of dams—Seismicity—Reservoir Induced Seismicity—post-construction problems: leakage, seepage and water logging. **(16 hours)**

MODULE 7

Foundation investigations for bridges and multi storey structures.

Geotechnical investigations for route locations in hilly terrains for road and rail alignments.

Tunnels: Classification and terminology--geological factors in tunneling in igneous, sedimentary and metamorphic terrains. **(18 hours)**

MODULE 8

Landslides: Engineering classification –graphical analysis of slope stability—calculation of Factor of safety—causes and prevention of landslides. Hazard zonation mapping and application of Remote sensing data.

Basic engineering and geological principles in shore line engineering structures-Tsunami resistant structures. Terrain modeling-Lineament and Tectonics. **(14 hours)**

Mark: External (ESE): 48 **Hrs/week: 7; Total Hrs: 126; Credits: 4**
Internal (CE): 12

GEO2C 06- QUATERNARY GEOLOGY & SEDIMENTOLOGY

QUATERNARY GEOLOGY

MODULE 1

Quaternary-concept and significance-subdivisions. Climate and climate variability: various time scales of climate variability. Various Archives of Quaternary history; tree rings, corals, speleothems (cave deposits), peat deposits, dunes, lake sediments, marine sediments, glaciers, fluvial deposits. Use of 'proxy indicators' for the reconstruction of Quaternary environments--geological, geochemical, biological, sedimentological, isotopic and magnetic proxies.

(16 hours)

MODULE 2

Beginning of glaciation- Palaeoceanographic changes during Cenozoic--Deducing sequence of climate changes and environment during Quaternary from the proxies--D-O Events, Bond Cycles and Heinrich Events - Quaternary history from marine sediments, land and ice core studies. Tertiary-Quaternary boundary.

Ice Ages during Quaternary--Factors controlling glacial cycles. Various stages in Quaternary glaciations. Eustatic Sea Level changes and their global significance. Astronomical theory of glaciation—Milankovitch cycles and its appreciation. **(16 hours)**

MODULE 3

Evolution of life during Quaternary-Hominids. Dating of Quaternary rocks. Thermoluminescence and radiocarbon dating. The history, causes and evolution of Asian monsoons-Monsoon-related palaeo-oceanographical changes during Quaternary, Quaternary glaciation in India. Evolution of Thar desert and Indo-Gangetic Alluvial Plains.

(16 hours)

MODULE 4

Environmental magnetism. Introduction, principles, techniques--application in Quaternary environment reconstruction. Magnetic properties of natural minerals. Magnetic remnants and magnetic susceptibility. Magnetic minerals and environmental system. Comparison with palaeomagnetism. **(14 hours)**

SEDIMENTOLOGY

MODULE 5

Sedimentary textures: Concept of Size, Shape and Fabric--Frequency distribution and Statistical parameters. Sediment movement by fluid flow--Fundamentals of fluid flow. Flow in pipes and channels competence and capacity. Turbulence, suspended load and bed load – Froude Number, Reynold's Number--use of textures of sedimentary rocks in analyzing palaeo-environment. **(14 hours)**

MODULE 6

Sedimentary structures: Stratification, flow regimes, ripples and dunes, antidunes, large bed forms--sand waves, ridges and bars. Structures formed by scour, wave, tide and wind. Mass flows, Turbidity currents. Penecontemporaneous deformation, Biogenic sedimentary structures. Uses of sedimentary structures in analyzing palaeo environment.

(16 hours)

MODULE 7

Provenance studies: Mobility of oxides, mineral stability, mineralogical maturity, minerals of sedimentary rocks and source rocks. Heavy mineral suits. Sedimentary facies and environments. Facies models.
Sedimentary petrology: Sandstones, Mudrocks and Limestones. Diagenesis of clastic and non-clastic rocks--diagenetic processes and diagenetic environments. **(18 hours)**

MODULE 8

Paleogeography: Paleoslope and palaeo current studies—basin analysis—tectonics and sedimentation—sedimentary basins of India--cyclic sediments—Sequence stratigraphy. **(16 hours)**

Marks: External (ESE): 48 **Hrs/week: 7; Total Hrs: 126; Credits: 4**
Internal (CE): 12

GEO 2E 01- EXPLORATION GEOLOGY & GEOPHYSICS

EXPLORATION GEOLOGY

MODULE 1

Guides to Mineral Prospecting—Prospecting and Exploration—geological exploration. Exploratory grids, location and documentation.
Exploratory workings: Pitting, Trenching, underground workings and boreholes—delineation of ore deposit based on exploration data.
Classification of Mineral Resources and Ore Reserves. Ore Reserve estimation. Economic evaluation of ore deposits. Problems in Averaging Assays. Cut off grade . **(16 hours)**

MODULE 2

Sampling techniques and evaluation of grade: Types of sampling methods--Rock sampling, soil sampling, water sampling , vegetation sampling and vapour sampling.
Drilling: Design of a drilling programme--drilling methods—Percussion, Rotary and miscellaneous--Vertical and inclined drill holes--Logging of boreholes--Borehole Deviations. **(14 hours)**

MODULE 3

Geochemical Exploration techniques: Geochemical mobility of elements—factors controlling mobility of elements in the surficial environments. Gossans--Threshold values and geochemical anomalies. Primary dispersion pattern of deep-seated ores. Diffusion and leakage anomalies. **(16 hours)**

MODULE 4

Geochemical Rock surveys. Geochemical Soil surveys: Hydromorphic anomalies in residual soils and transported overburden. Geochemical Drainage surveys. Anomalies in ground and surface waters.
Uptake of mineral matters by plants—Bio-geochemical surveys and techniques—Geobotanical methods of mineral prospecting—Accumulator and Indicator plants—universal and local indicators. **(18 hours)**

GEOPHYSICS

MODULE 5

Introduction to Geophysical Prospecting: Geophysical exploration techniques and their importance.
Magnetic Surveys: Principles and Earth's magnetic field--survey methods, instrumentation, interpretation and applications. **(14 hours)**

MODULE 6

Gravity surveys: Principles of Gravity survey, instrumentation, Bouger anomaly, latitude, elevation and terrain corrections survey methods interpretation of gravity curves of bodies of different shapes.
Radiometric methods: Instrumentation and techniques. **(16 hours)**

MODULE 7

Seismic surveys: Methods of generation, propagation and sensing of seismic waves, wave types, travel-time graphs for different media and interfaces. Seismic velocities in geological materials. Seismic survey sources, recorders, reflections and refraction surveys and the interpretation of profiles. **(16 hours)**

MODULE 8

Electrical surveys: Electrical properties of rocks, theory of current flow in different media, resistivity survey, application and interpretation of data. Self-Potential survey, applications and interpretation of data.
Induced Polarization, application and interpretation of profiles.
Theory, survey methods and interpretation of data.
Bore-hole logging: Electrical, Radiometric, Sonic and Thermal logging of boreholes. **(16 hours)**

Marks: External (ESE): 48 **Hrs/week: 7; Total Hrs: 126; Credits: 4**
Internal (CE): 12

GEO2E02 - OCEANOGRAPHY

MODULE 1
Physical Oceanography: T-S diagrams; mixing processes in the oceans; characteristics of important water masses. Wind generated waves in the oceans; their characteristics; shallow and deep water waves. Propagation, refraction, and reflection of waves. Wave spectrum, principles of wave forecasting**.** **(16hours)**

MODULE 2
Tide-producing forces and their magnitudes; prediction of tides by the harmonic method; tides and tidal currents in shallow seas, estuaries and rivers. Factors influencing coastal processes; transformation of waves in shallow water; effects of stratification; effect of bottom friction, **(14hours)**

MODULE 3
Ocean circulation: forces driving currents; surface currents – flow within a gyre, geostrophic gyres, current within gyres, counter currents and under currents, effects of surface currents on climate; thermohaline circulation - thermohaline circulation patterns, global heat connection.
(16hours)

MODULE 4
The global wind system; action of wind on ocean surface; Ekman's theory; Sverdrup, Stommel and Munk's theories; upwelling and sinking with special reference to the Indian Ocean. Coastal upwelling - its physical, chemical, biological characteristics, physical structure and dynamics, the chemical characteristics of upwelling systems, the biological characteristics of upwelling areas. **(16hours)**

MODULE 5
Formation of subtropical gyres; western boundary currents; equatorial current systems; El Nino; monsoonal winds and currents over the North Indian Ocean; Somali current; southern ocean. Upwelling process in the Arabian Sea.
(14hours)

MODULE 6
Chemical oceanography: Composition of seawater – Classification of elements based on their distribution; major and minor elements, their behaviour and chemical exchanges across interfaces and residence times in seawater. Element chemistry in atypical conditions-estuaries, hydrothermal vents, anoxic basins, HNLC waters, sediment pore fluid and anthropogenic inputs. **(16hours)**

MODULE 7
Chemical and biological interactions – Ionic interactions; biochemical cycling of nutrients, trace metals and organic matter. Air-sea exchange of important biogenic dissolved gases; carbon dioxide-carbonate system; alkalinity and control of pH; biological pump. Factors affecting sedimentary deposits-$CaCO_3$, Silicate, Manganese nodules, phosphorites and massive single deposits**.** **(16hours)**

MODULE 8
Biological oceanography: Classification of the marine environment and marine organisms. Physio-chemical factors affecting marine life – light, temperature, salinity, pressure, nutrients, dissolved gases; adaptation and biological processes. Primary and secondary production; factors controlling phytoplankton and zooplankton abundance and diversity; nekton and fisheries oceanography; benthic organisms; coastal marine communities and community ecology – estuaries, coral reefs and mangrove communities**.** **(18hours)**

Marks: External (ESE): 48 **Hrs/week: 7; Total Hrs: 126; Credits: 4**
Internal (CE): 12

GEO2E03 -GEOTECTONICS

MODULE 1

Internal structure and mechanics of earth: Seismic investigations of the earth's interior, waves velocity, velocity curves, density distribution, elastic properties, pressure and temperature within the earth. Bulk composition of the earth and of its various zones. Composition of the earth's crust and upper mantle and crust-mantle relationship. Gravity anomalies, isostasy.

(16 Hours)

MODULE 2

Sea floor spreading and plate movement: Concept of continental drift, geological and geophysical evidence, mechanics, objections, present status. Evidences of sea floor spreading, magmatic anomaly patterns, age of ocean sediments. Gravity and magnetic anomalies at Mid-ocean ridges. Continental shield areas and mountain chains.

(16 Hours)

MODULE 3

Geomagnetism: Origin of Earth's magnetic field, magnetization, types, natural remanent magnetism, magnetic field reversals, polar wandering curve, magnetic polarity time scale, secular and transient variations and their theories;application in geology.

(14 Hours)

MODULE 4

Modern concept of plate tectonics. Nature of plate margins and their geometry, convergent, divergent and transform plate boundaries, mosaic of plates, direction of motion. Oceanic ridges and trenches, benioff zone, island arcs, triple junction.

(16 Hours)

MODULE 5

Causes of plate motion: Mantle convection, convection plumes, slab pull, ridge push and other hypothesis. Wilson Cycle. Heat flow mechanisms, thermal modelling of earth.

(14 Hours)

MODULE 6

Tectonic evolution of Himalaya: Convergence of continents, pre-Himalayan sedimentation, closing of continents, rotation of continental block, phases of deformation, shifting of depositional basins, vertical tectonics.

(16 Hours)

MODULE 7

Geodynamics of Indian plate, Drift and subduction of Indian plate, Andaman subduction zone, Andaman sea spreading centre and Makran subduction zone. Indus-Tsangpo suture zone, Main Central Thrust, Main Boundary Fault, Siwalik structure, Himalayan Frontal Fault, evolution of Himalaya. Neotectonic evidences in parts of Himalaya.

(16 Hours)

MODULE 8

Tectonic evolution of Indian craton, Evolutionary history and structural layout South Indian craton, Central Indian craton and East Indian region. Gravity conditions in Indian craton.

(16 Hours)

Marks: External (ESE): 80 **Hrs/week: 4; Total Hrs: 72; Credits: 4**
Internal (CE): 20

GEO 2P 02- GEOMORPHOLOGY, REMOTE SENSING, CRYSTALLOGRAPHY & MINERALOGY

GEOMORPHOLOGY

Interpretation of topographic Maps and identification of geomorphic features like topography, drainage, fluvial and coastal erosional and depositional landforms.

Calculation of surface area and slope. Study of drainage pattern, Stream Ordering, tracing of drainage network and morphometric analysis. Determination of drainage density. Identification of lineaments and preparation of lineament maps. **(18 hours)**

REMOTE SENSING

Aerial Photography: Simple calculations based on aerial photos—photo scale, estimation of total number of photos required to cover a given area and determination of heights of objects.

Interpretation of aerial photos with special reference to topography, drainage, structure and geology using Pocket Stereoscope and Mirror Stereoscope.

Interpretation of satellite imageries: Identification and mapping of drainage patterns, lineaments, litho contacts, geological structures and preparation of geological maps. Identification of land use patterns and environmental features. Land use/cover classification. **(18 hours)**

CRYSTALLOGRAPHY

Stereographic, Gnomonic and Spherical projections of Normal class of Isometric System. --3 exercises.

Axial ratios, Zone symbols and Napier's rule. **(10hours)**

MINERALOGY

Identification of typical mineral hand specimens based on physical properties.

Determination of the following optical characters of minerals by classical methods:-

1) Relative Refringence
2) Order of Interference Colour
3) Sign of Elongation
4) Birefringence
5) Scheme of Pleochroism and Absorption Formula
6) Optic Orientation
7) Optic Axial Angle
8) Extinction Angle
9) Anorthite content using U-Stage.
10) Twin laws using U-Stage
11) Optic Sign **(26 hours)**

Marks: External (ESE): 80 **Hrs/week: 4; Total Hrs: 72; Credits: 4**
Internal (CE): 20

GEO 2P03 - SEDIMENTOLOGY AND STRUCTURAL GEOLOGY

SEDIMENTOLOGY

Textural analysis of sediments: Sieve analysis, settling analysis, thin sections, size analysis, measurement and calculation of Shape parameters, plotting and interpretation of such data.

Heavy mineral separation.

Study of thin sections and hand specimens of Limestone, Sandstone, Shale, Conglomerate, Breccia, Grit and Arkoses.

Preparation of grain mounts - 5 Nos.

Study of grain mounts of Magnetite, Ilmenite, Monazite, Garnet, Sillimanite, Quartz, Zircon, Leucoxene and Chromite.

(**36hours)**

STRUCTURAL GEOLOGY

Interpretation of complex geological maps - 25 Nos.

Trigonometric, graphic and stereographic solution to problems in structural geology.

Fabric diagrams, Rose diagrams and Histograms.

Geometric analysis of planar and linear structures.

Interpretation of topography, structures, metamorphism, lithology and geological history of

Typical Precambrian terrains-5Nos.

(**36hours)**

Marks: External (ESE): 80 **Hrs/week: 5; Total Hrs: 90; Credits: 4**
Internal (CE): 12

GEO 3C 07 – IGNEOUS & METAMORPHIC PETROLOGY

IGNEOUS PETROLOGY

MODULE 1

Formation of magma: petrotectonic settings: Mid-Oceanic Ridges, Subduction Zones, Hotspots. Pressure, temperature and depth of origin of magmas. Isotopic signatures of source-rock relation. Mantle heterogeneity and importance of strontium isotopic ratios. Bowen's Reaction Principle and Series. Magmatic evolution. Fractional Crystallization. Magmatic differentiation. Importance of Rare Earth Elements in understanding igneous rocks.

(10 hours)

MODULE 2

Importance of Le Chatelier's principle and Phase rule in igneous petrology. Eutectic, peritectic and solid solution relations. Phase diagrams of unary, binary and ternary systems. Primitive system and residua system. Study of the following systems:
MgO-Al2O3-SiO2
Anorthite- Wollastonite-Silica
Forsterite-Anorthite-Silica
Diopside-Albite-Anorthite
Diopside-Forsterite-Silica
Orthoclase-Anorthite-Albite **(12 hours)**

MODULE 3

Detailed study of IUGS Classification of volcanic, plutonic, mafic and ultramafic rocks. TAS classification and Irvin-Baraggar classification. Use of Variation Diagrams and Ternary (FMA) diagrams for igneous rock classification. Genetic significance of structures and textures of igneous rocks.

Igneous rocks and associations: Igneous rocks of oceanic regions, Igneous rocks associated with convergent plate boundaries, continental flood basalts and associated rocks, large layered igneous complexes, continental alkaline rocks.
(14 hours)

MODULE 4

Study of the following rocks with special reference to genetic history and petrotectonics: Kimberlites, Carbonatites, Anorthosites, Komatiites, Lunar rocks, Basalts, Andesites, Ophiolites, Alkaline rocks, Lamprophyres and Granites (I, S and A types). Igneous intrusives of Kerala. **(10hours)**

METAMORPHIC PETROLOGY

MODULE 5

Kinds, factors and kinetics of metamorphism. Solid-solid reactions, role of fluid phases, concentration of CO_2 and Oxygen in the fluid phases. Geothermometry and geobarometry, fluid inclusions. **(10 hours)**

MODULE 6

Genetic significance of textures and structures of metamorphic rocks. Metamorphism of calcareous, argillaceous, mafic and ultramafic rocks. Mineral paragenesis and Graphical representation. Composition plotting: ACF, AKF and AFM diagrams.
Concept of metamorphic zones, facies, facies series and grade. Isograds and Reaction Isograds. **(14hours)**

MODULE 7

Prograde and Retrograde metamorphism.
Metasomatism, Magmatism, Granitisation, Metamorphism and Orogeny.
Paired Metamorphic Belts. **(10 hours)**

MODULE 8

Petrogenesis and petrography of the following rocks:
Charnockites, Migmatites, Gneisses, Schists, Slates, Phyllites, Amphibolites, Granulites, Marble and Quartzites.
Granulite facies rocks with special reference to Charnockites and Khondalites of South India. **(10 hours)**

Marks: External (ESE): 48 **Hrs/week: 5; Total Hrs: 90; Credits: 4**
Internal (CE): 12

GEO 3C 08- STRATIGRAPHY & PALAEONTOLOGY

STRATIGRAPHY

MODULE 1

Historical development of stratigraphic principles and concepts—Ancient and modern ideas-- Contributions of Steno, Lehmann, Fuchsel, Werner, Hutton, Lyell, Darwin, Smith, Phillips, Sedgwick, Murchison and Holmes.
Evolution of Geological Time Scale.
Stratigraphic procedures—Surface procedures, Subsurface procedure. Code of Stratigraphic Nomenclature.
Modern Stratigraphic Classification: Lithostratigraphic, Biostratigraphic & Chronostratigraphic units. **(10 hours)**

MODULE 2

Major geological events during the Precambrian. Evolution of atmosphere, hydrosphere and Precambrian crust. Precambrian stratigraphy: Precambrian Crust--Nature of primitive crust and characteristic features of Achaean crust. --Cratons, Shield areas and Precambrian Mobile belts. Greenstone belts--origins, rock associations, structure, metamorphism and models for evolution. Granulites belts of South India.
Precambrian geology of Kerala: Wayanad and Vengad Group and associated intrusives.
Classification and stratigraphy of Indian Proterozoic rocks--Cuddapah and Vindhyan Supergroups. Age of Vindhyans. **(12 hours)**

MODULE 3

Major geologic events during the Phanerozoic Eon. Age problems in stratigraphy with special reference to the Indian sub-continent – Saline series, Gondwana glaciation and Deccan traps. Boundary problems—Permian-Triassic and Cretaceous-Tertiary. **(10 hours)**

MODULE 4

Concept of Gondwanaland – general consideration and equivalents in other parts of the world. Classification, Stratigraphy and fossils of Jurassic of Kutch and Cretaceous of Tiruchirappally. **(12 hours)**

PALAEONTOLOGY

MODULE 5

Palaeontology – nature of fossil record. Distribution of main groups in time. Importance of fossils in palaeoclimatic and palaeogeographic studies.
Invertebrates – Trends in the evolution of the following: Brachiopoda, Pelecypoda, Nautiloidea, Ammonioidea, Trilobita, Graptozoa and Echinoidea. **(12 hours)**

MODULE 6

Models for origin and early stages of evolution of life: extra-terrestrial and terrestrial. Fossil records—Miller's experiment—Theories of Chemical and Organic evolution. General characteristics of Precambrian Stromatolites their classification, evolution and distribution in India. Evolution of life during Precambrian, Palaeozoic, Mesozoic and Cenozoic Eras. Mass extinction and its causes. **(10 hours)**

MODULE 7

Vertebrate Palaeontology – General characteristics and evolution of Pisces, Amphibians, Reptiles, Birds and Mammals. Basic morphologic characters and evolution of Horses, Elephants and Man.
Principal groups of vertebrates in Gondwana and Siwalik formations. **(12 hours)**

MODULE 8

Micropalaeontology: scope and subdivisions—types, extraction of microfossils from sediments and sedimentary rocks. Foraminifera: their palaeoecology and application in petroleum exploration. Radiolaria, Diatoms, Ostracoda, Pteropods and Conodonts—morphology and classification. Application of microfossils in petroleum exploration.
Stratigraphic and environmental significance of microfossils.
Palynology--General morphology of spores and pollens and their classification. Palaeobotany: Plant life through geological ages. Morphology and taxonomy of selected mega plant fossils of Gondwana Super group. **(12 hours)**

Marks: External (ESE): 48 **Hrs/week: 5; Total Hrs: 90; Credits: 4**
Internal (CE): 12

GEO 3C 09 – GEOCHEMISTRY & ISOTOPE GEOLOGY

GEOCHEMISTRY

MODULE 1

Geochemistry: Historical development and scope. Origin and cosmic abundance of elements. Geochemical classification of elements. Primary differentiation of elements: Distribution and behaviour of major, trace and Rare Earth Elements (REE) in igneous, sedimentary and metamorphic environments. Applications of major, minor, Rare Earth Elements and Platinum Group of Elements in geochemistry. **(11 hours)**

MODULE 2

Geochemistry of crust, mantle and core of the earth. Geochemistry of meteorites. Geochemical Cycle. Mobility of elements, Isomorphism, polymorphism and atomic substitution. **(12 hours)**

MODULE 3

Application of Thermodynamics in Geochemistry: Phase rule, Eh, pH, limits of Eh and pH in nature. Eh-pH diagrams. Free energy: Definition of free energy and its limitations. Free energies of formation, Gibb's free energy; change of enthalpy and entropy; Chemical potential, fugacity and Oxidation-Reduction potentials. Phase rule formulation: one component system and two component system; Eutectics and solid solution. **(12 hours)**

MODULE 4

Analytical techniques: methods based on emission and absorption spectra, principles and methodology. Flame Photometer, Spectrophotometer, Atomic Absorption Spectrometer (AAS), Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) and Isotope Mass Spectrometers. Methods based on electron properties: X-ray diffraction. Methods based on magnetic properties. **(10 hours)**

ISOTOPE GEOLOGY

MODULE 5

Introduction to isotope geology: Isotopes, isobars and isotones, stable and radioactive isotopes.Various decay mechanisms- alpha, beta (positron and negatron), gamma decay, electron capture and branched decay. Radioactive decay, half-life and basic equation for age calculation. **(11 hours)**

MODULE 6

Study of different radioactive systematics: Rb-Sr –model age and isochron age, mineral and whole rock isochrones, their merits and demerits. Importance of Sr initial concentration in understanding the source characteristics of igneous and metamorphic rocks K-Ar systematics-model age and isochron age, the problem of Ar loss, metamorphic veil and rate of cooling intrusives. **(12 hours)**

MODULE 7

Sm-Nd sytematics, isochron ages, isotopic evolution of Nd, CHUR model, epsilon Nd parameter and nature of mantle source, crustal residence of igneous and metamorphic rocks. U-Th-Pb systematics-model age, ^{207}Pb-^{206}Pb method, U-Pb Concordia-discordia method, U-Pb, Th-Pb isochron methods, Zircon dating- analysis of single zircon and SHRIMP analysis. ^{14}C and fission track methods of dating. **(12 hours)**

MODULE 8

Stable isotope studies- Delta notation and its significance, significance of stable isotopes of Carbon, Oxygen and Sulphur in petrology. Isotope hydrogeology - $\delta^{18}O$ and $\delta^{2}H$-, Global meteoric water line, altitude, attitude and latitudinal effects on rain water. **(10 hours)**

Marks: External (ESE): 48 **Hrs/week: 4; Total Hrs: 72; Credits: 4**
Internal (CE): 12

GEO 3E 04 – ENVIRONMENTAL GEOLOGY

MODULE 1

Environmental Geology: Scope of environmental geoscience. Natural resources: - Renewable resources, non-renewable resources. Sustainable management of resources. Conservation and preservation.
Alternative energy sources – bio mass energy, wind energy, solar energy, geothermal energy, tidal energy, wave energy, ocean thermal energy and other alternate emerging energy sources for the future.
Land, its uses and management--Resources of the ocean floor.
Mineral Resources: Conservation, management and concept of sustainable development. **(10 hours)**

MODULE 2

Natural hazards: Earthquakes and seismic hazards, earthquake prediction and protection. Cyclones-effects and control measures.
Coastal hazards--Tsunamis, coastal erosion, sea level changes and impact on coastal areas.
Landslides--Identification of landslide-prone areas – Flood hazards and its management.
Droughts—Causes and prevention. Zoning and risk assessment-- Hazard Zonation maps.
Disaster Management: introduction, identification of areas, causes, prevention and management. **(8 hours)**

MODULE 3

Waste Management: Changing concepts of wastes, their disposal, solid, liquid, gaseous and radioactive wastes. Waste management – Prevention, minimization, re-use, recycling. Waste disposal methods – open dumping, incineration, pyrolysis, gasification, landfill, area landfill method, depression landfill method, suitable sites for waste disposal, secure landfills, hazardous chemical waste, deep well disposal, ocean dumping and waste water treatment. Waste generation due to mining, environmental impacts of mining activities on land surface, air and water environment. Mine site decommissioning. **(10 hours)**

MODULE 4

Pollution: Problems of pollution of geospheres and waste management. Pollution and climatic changes. Greenhouse Effect and Ozone Layer Depletion. Impacts of mining on depositional environments, reservoirs, lakes, lagoons and estuarine environments.
Radioactive pollution – Radioactivity, characteristics of radioactive waste. Classification – low level, intermediate level and high level. Disposal of high level radioactive waste. Soil pollution- sources, effects and control . **(8 hours)**

MODULE 5

Groundwater pollution – Sources of groundwater pollution- heavy metals, radioactive materials, acid mine drainage, fluoride, pesticide, fertilizers and arsenic contaminations. Collection and treatment, detoxification and biodegradation, health hazards due to ground water pollution, microbes, BOD and COD. Controls of ground water pollution. Marine Pollution: Marine Pollution: Sources of marine pollution – industrial effluents, marine ship effluents, oil spillage, inflow of fertilizers and pesticides, nuclear waste. Major impacts of marine pollution

(9 hours)

MODULE 6

Development of technology and human factors. Environmental geologic mapping. Environmental change: natural and man-made. Prediction of environmental changes and areas of human concern and impact indicators.
Geology and urban planning. Problems of urbanization. Desertification – causes, symptoms and prevention. Soil erosion- causes, effects and control. **(9 hours)**

MODULE 7

EIA: Introduction, Definition, aim, principles and concept. Relationship of EIA in sustainable development.
Methods for preparing EIA: Socio-economic aspects, making inventories, sampling and data process, baseline study.
Impact prediction: Positive and negative impact, primary and secondary impact, impact on physical, social and biotic environment. evaluation of proposed action: Risk assessment and risk management, mitigation measures, comparison of alternatives, Review and decision making, Practices and guidelines in India. **(9 hours)**

MODULE 8

EIA for different environmental programmes: Industries, urban development, landuse, Energy projects-Hydel, Thermal, Nuclear, oil and gas.
Environmental Impact Analysis of dams, buildings, highways and tunnels. EIA case studies. **(9 hours)**

Marks: External (ESE): 48 **Hrs/week: 5; Total Hrs: 90; Credits: 4**
Internal (CE): 12

GEO 3E 05 -PLANETARY GEOLOGY

MODULE 1

Earth in space - Universe, Big Bang theory, milkyway, solar system, sun. Astronomical units. Inner planets" Outer planets, planetoids, moons **(12 hrs)**

MODULE 2

Origin of planets - nebular hypothesis, planetary hypothesis, double star hypothesis, condensation hypothesis, Urey's hypothesis. Origin of Earth's atmosphere. **(12 hrs)**

MODULE 3

Portraits of planets - Earth's moon, general features, surface aspects. Origin of lunar surface. Geology of surface cover, sediment, volcanic flows, lunar craters. Structure of moon - crust and interior. Absence of atmosphere, origin and evolution of moon. **(10 hrs)**

MODULE 4

Terrestrial planets-Mercury, Venus, Mars- physical attributes. General survey of atmosphere, atmospheric temperature, planetary surfaces and their morphology. Structure of planet-lithological make up of crust and interior and origin of the crust. **(10 hrs)**

MODULE 5

Outer planets- Jupiter, Uranus, Saturn, Neptune- physical attributes. General survey of atmosphere, atmospheric temperature, planetary surfaces and their morphology. Structure of planet-lithological make up of crust and interior and origin of the crust. **(10 hrs)**

MODULE 6

Other planetary objects- meteors, meteorites- classification of meteorites, asteroids, comets, origin, evidence of giant impacts spinifex texture, tektites, petrology of meteorites. **(10 hrs)**

MODULE 7

Closer look on Saturn, observation methods, Saturn's rings, Saturn’s moons, Kuiper Belt.

(8 hrs)

MODULE 8

Planetary exploration, Space crafts- Gemini series, Apollo missions, lunar rovers, first lunar landing. International Space station, Seismic method of exploration, Remote Sensing of physical and chemical attributes of planets. Indian initiatives in planetary exploration.

(8 hrs)

Marks: External (ESE): 48 **Hrs/week: 5; Total Hrs: 90; Credits: 4**
Internal (CE): 12

GEO 3E 06-GEOCHRONOLOGY

MODULE 1

Introduction to Geochronology: Importance of Dating in Geology--different Dating methods--Age of the Earth-different methods to determine the Age of the Earth. **(10 hours)**

MODULE 2

Principles of Isotopic Dating - Radioactivity and radioactive decay schemes and their application to Geochronology. Growth of Daughter Isotopes --Kinds of radiogenic isotopes: Strontium isotopes, Lead isotopes, Neodymium isotopes. **(12 hours)**

MODULE 3

Application of Isotope Geochemistry: U-Pb, K-Ar, Rb-Sr and Sm-Nd. Dating methods for deformation and metamorphic events --Geochronometers. **(14 hours)**

MODULE 4

Stable Isotopes (Oxygen, Carbon, Hydrogen and Sulphur) and their application to Geochronology. Oxygen Isotope Stratigraphy by orbital tuning. Cosmogenic Dating--in-situ cosmogenic nuclides (^{10}Be, ^{26}Al, ^{36}Cl) in Dating. **(12 hours)**

MODULE 5

Radiocarbon Dating: Production of ^{14}C in the atmosphere. Incorporation into living material, preservation. Changes in atmospheric ^{14}C concentrations over time. AMS Dating. Calibration methods. Reservoir correction. Application in late Quaternary climate changes. Application of ^{14}C Dating methods. **(10 hours)**

MODULE 6

Thermo-luminescence, OSL and Fission Track Dating methods--Different methods of Luminescence Dating. Principle and applications to Quaternary climate studies. Archaeology. **(10 hours)**

MODULE 7

Application and Principles of Dendrochronology, Magnetostratigraphy, Tephrochronology, Lichenometry, Varve stratigraphy and Biostratigraphy. Age markers in biostratigraphy--Last Appearance Datum (LAD) and First Appearance Datum (FAD). Comparisons-- Advantages and Drawbacks of different Dating methods. **(10 hours)**

MODULE 8

Radiometric Dating of Precambrian rocks: distribution of dates in space and time. Classification of Precambrian based on radiometric age data. Precambrian orogenic cycles of Peninsular India from radiometric age data. Correlation of the cycles with Canadian and Baltic shield. **(12 hours)**

Marks: External (ESE):0 **Hrs/week: 2; Total Hrs: 36; Credits: 2**
Internal (CE): 60

GEO 3C 10 - FIELD MAPPING

Students should be exposed to field mapping in hard rock terrain continuously for 7 days during or at the end of 3rd semester classes. Geological field mapping can be carried out by selecting an area of interest and identifying all the geological aspects of that area with the purpose of preparing a detailed geological report which must include a map. It is to equip the students for accepting a career of the geologist. Certain parameters must be considered when mapping geology, geological landforms and structures- accuracy and precision. The resulting geological map should be compiled and interpreted. All the features observed in the field may be super imposed over a topographic map or a base map. With the development of technology combination of satellite imagery, aerial photographs, high tech geological equipment and Geographic Information Systems (GIS) etc . can be combined to prepare the report. Exploitation of all natural resources requires the understanding of basic geology. Geological mapping is usually the first task in any reconnaissance study.

Phases of geological mapping

Field mapping projects are carried out in three phases which have a stepwise relationship.

1. Planning/research

2. Observing/mapping/collecting .The data may be collected in the form of photographs, measurements, notes and physical samples. It is advisable to plan for field studies during the dry seasons. It is in the best interest of everyone to commence mapping work very early in the morning so as to accomplish a substantial amount of work before the temperatures rise too high. Teamwork should be encouraged. A mapping project must be qualitative as well as quantitative.

3. Reporting -When all possible available data has been collected it is taken back to the laboratory for sorting, interpretation and analysis.

Tools and equipment used in geological field mapping

Toposheets , Aerial photographs and stereoscope , Brunton Compass/Clinometer: GPS(Geographic Positioning System) Geological hammer ,Hand held lens, Sample bags, Measuring tape, Field notebook, marker pens: Field camera etc.

Summary

The following can be said to summarize geological field mapping:

- For geological field mapping to be carried out efficiently, it is essential that proper planning is executed.
- Once in the field, it is also important to be as detailed as possible in all descriptions, to be keen and observant.
- Measurements must be performed meticulously and, if necessary, more than once for confirmation purposes.
- Team work must be adhered to, throughout the entire process.

Marks: External (ESE): 48 **Hrs/week: 6; Total Hrs: 108; Credits: 4**
Internal (CE): 12

GEO 4C 11- ECONOMIC GEOLOGY & MINING GEOLOGY

MODULE 1
Classification of ore deposits. Morphology and structure of ore deposits. Ore bearing fluids--magmas, magmatic fluids, meteoric waters and fluids associated with metamorphic processes. Migration of ore-bearing fluids. Physical and chemical controls of ore localization. Metallogenic Epochs and Provinces. **(10 hours)**

MODULE 2
Processes of ore formation: magmatism, metamorphism, metasomatism, sedimentation, evaporation, hydrothermal concentration, weathering, mechanical concentration and supergene alteration. Affinity of ore deposits and rock types. Ore deposits associated with anorthosites, Kimberlites, ophiolites, basalts, komatiites, Carbonatites, pegmatites, silicic igneous rocks and laterites. **(14 hours)**

MODULE 3
Basic Principles of Mineral Economics: Strategic, Critical and Essential minerals of India. National Mineral Policy. Polymetallic nodules and metalliferous muds: Depth of occurrence, conditions of formation, economic importance. Ore microscopy: Physical and optical properties. Ore textures and their genetic significance. **(14 hours)**

MODULE 4
Indian Mineral Deposits: Mode of occurrence, mineralogy, genesis, Indian occurrence of the following- Iron, Manganese, Chromium, Copper, Lead, Zinc, Gold, bauxite, Mica, Clay, Asbestos, Dolomite, Marble, Gemstones, Dimensional and Building Stones, Industrial minerals and rocks, Refractory minerals, Abrasives, Ceramic minerals, fertilizer minerals and radioactive minerals. **(16 hours)**

MINING GEOLOGY

MODULE 5
Mining Geology: Basic mining terminology. Classification of mining methods: Alluvial mining.
Open cast mining and Underground mining methods. **(12 hours)**

MODULE 6
Coal mining, Deep Sea bed mining and Petroleum mining methods.
Methods of Stoping, Shaft sinking, Mine supports, Mine Ventilation. Mine hazards and principles of mine evaluation. Role of geologist at operative mines. **(14 hours)**

MODULE 7
Mineral and Ore Beneficiation: Principles of Ore Dressing: Crushing and Grinding—Comminution units and Comminution practices—Sizing—Screening units. **(16 hours)**

MODULE 8
Classifying techniques—Filtering and Drying. Hydrocyclones: Classifiers and Gravity concentration units--Concentration by Washing, Scrubbing, Jigging, Tabling, Floatation—Froth floatation: Floatation reagents and practices. Magnetic and Electrostatic separation methods. Miscellaneous processes. **(12 hours)**

Marks: External (ESE): 48 **Hrs/week: 5; Total Hrs: 90; Credits: 4**
Internal (CE): 12

GEO 4C 12 HYDROGEOLOGY

MODULE 1
Hydrogeology: Scope and Introduction. Origin of ground water: Meteoric, Juvenile and connate waters. Hydrological Cycle: precipitation, surface runoff, infiltration and evapotranspiration. Subsurface movement and vertical distribution of ground water. Springs. Classification of rocks with respect to their water bearing properties- Aquifers, Aquicludes, Aquitards and Aquifuges. Geologic materials as aquifers: unconsolidated materials and consolidated rocks. Hydrostratigraphic units. Types of aquifers: Unconfined, Confined, Semiconfined, Semi-unconfined, leaky and coastal aquifers. **(10 hours)**

MODULE 2
Hydrogeological properties of rocks: porosity, void ratio, permeability, hydraulic conductivity, transmissivity, storativity, specific yield, specific retention. Laboratory methods of determining aquifer properties. Concept of Hydro geological environment: rock types, geological frame work, rock matrix, fractures, weathered hard rocks and surficial materials. **(12 hours)**

MODULE 3
Movement of ground water: forces causing ground water movements, fluid potentials, water table, piezometric surface. Theory of ground water flow: Darcy's law and its experimental verification--Range of validity of Darcy's law. Differential equation governing groundwater flow. Hydrogeological boundaries. Flow nets. Application of isotope studies and tracer techniques in ground water flow. **(12 hours)**

MODULE 4
Ground water exploration: Geological methods—lithological and structural mapping, fracture trace analysis. Hydrogeological methods—lithological classification with respect of hydrological properties. Geophysical methods: Electrical Resistivity methods—Wenner and Schlumberger methods. Seismic Refraction methods. Well logging: Spontaneous Potential Logging, Radiation logging, Gamma-gamma ray logging. Use of Aerial photos and satellite imageries in ground water prospecting. **(12 hours)**

MODULE 5
Well hydraulics: Aquifer tests, Pumping tests data analysis and recovery test. Drawdown, Steady Radial flow into a well in confined and unconfined aquifers –Theim's equation, Dupuit-Forhemeir equation. Unsteady Radial flow into wells—Theis, Chow's and Jacob's methods. **(12 hours)**

MODULE 6
Well design: Types of wells, drilling methods: Cable-tool drilling, Hydraulic Rotary, Reverse Rotary and Down the Hole Hammer drilling. Water Well Design Criteria: Grain size distribution, screens and casings. Maintenance of production wells—Production well specifications and tests. **(12 hours)**

MODULE 7
Ground water recharge: natural and artificial recharges. Hydraulic budget. Quality of ground water: Methods of collection and analysis of water samples. Physical, chemical and bacterial measures of water quality and its interpretation. The general occurrence of various constituents in ground water. Graphical representation of groundwater quality data--Collin's, Piper trilinear, Vector, Circular diagrams and Stiff's polygon. Quality of ground water standard for domestic, irrigation and industrial uses. **(10 hours)**

MODULE 8
Coastal aquifers and saline water intrusion—Ghyben-herzberg equation and its uses—slope, shape and movement of interface. Identification of saline zones and interfaces. Prevention and control of saline water intrusion. Groundwater development and management. Water conservation methods-rain water harvesting. National Water Policy. Ground Water Provinces of India. Ground water conditions of Kerala. **(10 hours)**

Marks: External (ESE): 48 **Hrs/week: 5; Total Hrs: 90; Credits: 4**
Internal (CE): 12

GEO 4E 07 -COAL AND PETROLEUM GEOLOGY

MODULE 1

Coal Geology: Formation of coal, periods of coal formation, Causes of coalification, Schurmann's and Hilts rule. Physical properties of coal – colour, lustre, fracture, cleavage, hardness, specific gravity, softening property, caking property, calorific values. Varieties and Ranks of Coal – Peat, lignite, bituminous, anthracite coal and other sub types. **(12 hours)**

MODULE 2

Stages in coal formation – humificaion and coalification processes. Origin of coal seams – Views supporting insitu and drift theory. Structure of coal seams – roof, floor and coal seam.

Chemical composition of Coal – Proximate analysis of coal - moisture content, volatile matter content, ash or mineral matter content, fixed carbon and calorific value. Ultimate analysis of coal – Carbon, hydrogen, nitrogen, oxygen and phosphorus. **(10 hours)**

MODULE 3

Coal Petrography – Stope's classification – vitrain, clarain, durain and fusain. Classification of Macerals – Origin definitely due to woody or cortical tissues, plant material other than woody tissues and origin not traced. Application of coal petrography. **(10 hours)**

MODULE 4

Introduction to Coal bed methane, occurrence and mode of formation. Distribution of coal in India. Geology of the Singareni, Raniganj and Jharia coal fields. Neyveli lignite fields. **(13 hours)**

MODULE 5

Petroleum Geology- Introduction, scope and importance. Geographic distribution of petroleum, stratigraphic distribution of petroleum. petroleum Classification – solid, liquid and gaseous forms. Physical and chemical properties of petroleum –Origin of Petroleum. **(10 hours)**

MODULE 6

Origin, migration and accumulation of petroleum. Properties of source and reservoir rocks. Structural, stratigraphic and combination traps. Cap rocks associated with traps. Petroleum Habitats - Depositional processes and environments. Shallow water, deep water deposition, carbonate platform deposits. **(12 hours)**

MODULE 7

Oil Field Exploration Processes- Geochemical, Gravity- Magnetic, seismic processes. Application of microfossils in petroleum exploration. Seismic stratigraphy & Sequence Analysis. Sub surface maps- Isopachs, Structure contour maps. Drilling Processes- Onshore and Offshore Drilling Technology. Well Testing Procedures- Types of testing, Reservoir Pressure and temperature and their importance. **(11 hours)**

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MODULE 8

Well Logging – Principles, basis and use of logging in stratigraphic correlation and detection of Hydrocarbons. Resistivity, water saturation, Archies Equation. Types of Logs – Resistivity ,SP, Gamma, Caliper, Porosity logs- Neutron and Sonic, Density, Dipmeter, CBL-VDL, Production logging and modern Schlumberger logs.

Introduction to Gas Hydrates, occurrence and mode of formation. Geology of the important petroliferous basins in India – Bombay, Cauvery and Assam. **(12 hours)**

Marks: External (ESE): 48 **Hrs/week: 5; Total Hrs: 90; Credits: 4**
Internal (CE): 12

GEO 4E 08 -FIELD GEOLOGY

FIELD GEOLOGY

MODULE 1
Scope and importance of Field Geology-- geologic maps and mapping, types of mapping, map symbols, reconnaissance, preparations. Basic equipment required for mapping and their uses: base map- Topographic map or aerial photograph, Brunton/Clinometer compass, hand lens, hammer, chisel, pen knife, hand lens, pocket magnet, field note book, etc. **(8 hours)**

MODULE 2
Basic procedures in the field: Taking a compass bearing, taping and pacing, locating the position in the map, Use of GPS. Observations in the field, interpretation of the outcrop, taking field notes, drawing and photographing outcrops, measuring attitudes of planar and linear features, finding and collecting fossils, collecting rock samples-their identification and naming. **(12 hours)**

MODULE 3
Mapping rock units and structures: Geologic pace and compass traverse, finding and tracing contacts between rock units, correlating geologic units, mapping geologic structures, outcrop maps, locating points in the field. Selecting and preparing a base map—locating field data and geologic features. **(12 hours)**

MODULE 4
Field studies and Mapping in sedimentary terrain: Beds and bedding, depositional bed forms and structures, palaeocurrent direction and palaeo slope direction, trace fossils, bioturbation, unconformities, beach and shelf deposits, marginal basin deposits of the deep sea. Subdividing and describing a section. Covered, deformed or laterally variable strata-- Preparing and presenting stratigraphic sections. **(10 hours)**

MODULE 5
Field studies and mapping in igneous terrain: Rock units, ages, inclusions in plutons, layering in plutons, schlieren and related structures, pegmatites and fracture systems in plutons.
Volcanic structures and field relations: map units, stratigraphy and ages, subaerial and subaqueous basaltic lavas, pyroclastic deposits. **(10 hours)**

MODULE 6
Field studies and mapping in metamorphic terrain: Protoliths of metamorphic rocks, mineral reactions and zones based on minerals and textures. Metasomatism, segregated metamorphic rocks, gneisses, migmatites, hydrothermal alterations, age of metamorphism and sequence of metamorphic events. **(14 hours)**

MODULE 7
Structural mapping: Identification and Mapping of Faults—folds—foliations, cleavages, lineations, joints, shear zones. **(12 hours)**

MODULE 8
Preparing final geological map and reports: Field study to report writing, major illustrations, photographs, drawings, diagrams, designing the report, format and specific parts of the report. **(12 hours)**

Marks: External (ESE): 48 **Hrs/week: 5; Total Hrs: 90; Credits: 4**
Internal (CE): 12

GEO 4E 09- INDUSTRIAL GEOLOGY

MODULE 1

Earth resources as raw materials and accessories for industries—important industrial metals and non-metals—important applications of geology—metallurgy, production of coal, petroleum and gas, gemstone cutting, abrasives, building materials and dimension stones, industrial minerals, refractories, ceramics and glass, fertilizers , chemicals and pigments. **(12 hours)**

MODULE 2

Industrial use of the following metals:
Platinum, Iron, Manganese, Chromium, Nickel, Copper, Lead, Zinc, Tin, Magnesium, Aluminium, Uranium, Thorium Cadmium and Mercury. **(12 hours)**

MODULE 3

Industrial use of the following non-metals:
Mica, Asbestos, Barites, Talc, Bentonite, Vermiculite, Glass sands, Diatomite, Fuller's Earth, Anhydrite, Gypsum, Coal and Graphite. **(12 hours)**

MODULE 4

Gem cutting: industrial applications of Gemstones and Diamonds—Dimensional and Decorative stones of India. Granite mining industries in India. Methods of production, polishing of granites and decorative stones.
Study of the following building materials:
Marble, Limestone, Quartzite, Sandstone, Slate and Sand. **(10 hours)**

MODULE 5

Study of the following Abrasives and Refractories:
Corundum, Garnet, Emery, Tripoli, Pumice, Feldspar, Dolomite, Magnesite, Chalk, Fire Clay, Sillimanite, Zircon and Pyrophyllite. **(10 hours)**

MODULE 6

Study of the following Ceramic, Fertilizer and chemical materials:
Clay, Wollastonite, Quartz, Apatite, Phosphorite, Lime, Rock salt, Borax, Fluorite, Sulphur and Ochre. **(12 hours)**

MODULE 7

Petroleum industry: production of petroleum—processing of oil—primary and secondary recovery of oil—mechanics of production and oil refining—distillation and cracking--Solid products. Petrochemicals and their processing. Hydrocarbon and non-hydrocarbon products. World Oil and future of oil industry. **(12 hours)**

MODULE 8

Industrial products and their market--Controlling factors. Raw material management—import and export—controlling factors. Role of earth resource management in selection of industrial sites.
Industrial pollution management: Management of particulate pollution from thermal power plants, cement, mining, coal and lignite industries.
Pollution in oil industry—Blow outs, Noise pollution, leaking pipelines and Oil spills. Control of pollution in oil industry—need for global awareness. **(10 hours)**

Marks: External (ESE): 80 **Hrs/week: 4; Total Hrs: 72; Credits: 4**
Internal (CE): 20

GEO 4P 05 - IGNEOUS PETROLOGY, METAMORPHIC PETROLOGY, PALAEONTOLOGY & GEOCHEMISTRY

IGNEOUS PETROLOGOY

Megascopic and microscopic of the following rocks with special stress to genetic significance:

Granite, Syenite, Diorite, Pegmatite, Aplite, Lamprophyre, Gabbro, Dolerite, Basalt, Dunite, Peridotite, Pyroxenite, Anorthosite and Kimberlite.

Petrochemical Calculations:

Norm, Salfemic Ratio, Scheme of crystallization, Differentiation Index, Determination of plagioclase—15 exercises.

Calculation of Niggli values and Peacock's Alkali Lime Index—2 Exercises.

Graphical representation:

Variation Diagrams--Harker, Larsen, Allen and Nockold, Niggli –2 each.

FMA diagrams for classification of igneous rocks—3 Nos.

Phase diagrams: Eutectic, Solid solution, and Peritectic—1 each. **18 hours**

METAMORPHIC PETROLOGY

Megascopic and microscopic studies of the following rocks with special reference to genetic significance.

Slate, Phyllite, Schist, Charnockite, Khondalite, Gneiss, Pyroxene granulite, Amphibolite, Mable, Quartzites.

Graphical representation of metamorphic mineral paragenesis—5 Exercises.

ACF and AKF diagrams of the following facies --1 each.

Greenschist, Amphibolite, Granulite, Eclogite, Albite-Epidote-Hornfels, Hornblende-hornfels, Pyroxene-hornfels and Sanidinite facies. **18 hours**

PALAEONTOLOGY

Separation of microfossils and preparation of palaeontological slides --5 Nos.

Identification and study of micro fossils in slides.

18 hours

GEOCHEMISTRY

Mineralogical calculations using chemical analysis data of simple minerals- Garnet, Olivine, Pyroxene, Feldspar, Feldspathoid **18 hours**

Marks: External (ESE): 80 **Hrs/week: 4; Total Hrs: 72; Credits: 4**
Internal (CE): 20

GEO 4P 06 - ECONOMIC GEOLOGY AND HYDROGEOLOGY

ECONOMIC GEOLOGY

Megascopic identification, characterization, paragenesis and occurrence of important minerals and economic resources of India--20 nos.

Identification of ore minerals under ore microscope -- 10 Nos.

Collection and graphical display of data on production, consumption and export of important mineral resources.

Calculation and determination of metal content in ore --10 exercises. **36hours**

HYDROGEOLOGY

Solution of problems based on Darcy's Law.

Preparation and interpretation of water table contour maps.

Computation of aquifer parameters from pumping data.

Collection of well inventory data.

Graphical representation of hydrochemical data:-

Piper Trilinear diagram, Vector diagram, Circular diagrams, Stiff's polygon.

Calculation of various parameters based on chemical data.

Electrical resistivity survey and interpretation of data.

Determination of pH of ground water samples -- 10 Nos. **36hours**

Marks: External (ESE): 120 **Hrs/week: 5; Total Hrs: 90; Credits: 4**
Internal (CE): 30

GEO 4 (Pr) - PROJECT / DISSERTATION

There shall be a project work with Dissertation to be undertaken by all students. The Dissertation entails field work, lab work, report, presentation and viva voce. Project work shall be carried out under the supervision of a teacher in the parent department. The candidate may be permitted to work on the project in an industrial / research organization on the recommendation of supervising teacher and the Head of the Department. In such cases, one of the teachers from the department concerned would be the supervisor/ internal guide and an expert from the industry/ research organization concerned shall act as co- supervisor/ external guide.

The project report shall be prepared according to the guidelines approved by the university. Two typed copies of the project report shall be submitted to the Head of the Department, two weeks before the commencement of the ESE of the final semester.

Every student has to do the project work independently. The project should be unique with respect to title, project content and project layout. Project report of students should not be identical.

LIST OF BOOKS FOR REFERENCE

GEO 1C O1- GEOMORPHOLOGY & REMOTE SENSING

Allum, J.A.E., 1978, Photogeology and Regional Mapping, Pergamon Press.
Avery, T.E., 1968, Interpretation of Aerial Potographs, Burges Publishing Co.
Bloom, A.L., 1992, Geomorphology, 2nd edn., Prentice Hall of India Pvt. Ltd., New Delhi.
Condie, K.C., 1979, Plate Tectonics and Crustal Evolution, Pergamon Press.
Cox, A., 1973, Plate Tectonics and Geomagnetic Reversals, Freeman.
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Dickinson, G.C., 1979, Maps and Air Photographs, Edward Arnold.
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Gass, I.G., at. al., (Editors.), 1971, Understanding the Earth, I edn., Academic Press.
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Lillesand, T.M., Kiefer, R.W. & Chapman, J.W., 2004, Remote Sensing and Image Interpretation, John Wiley &Sons.
Miller, V.C. & Miller, C.F., 1961, Photogeology, McGraw Hill Book Co. Inc., New York.
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Strahler, A. N., 1971, Earth Sciences, 2nd edn., Harper & Row.
Thornbury, W.D., 1968, Principles of Geomorphology, Wiley.
Turner, F.J., Weiss, M.P., et. al., 1972, The Earth, Holt, Reinhard & Winston.

GEO 1C 02 - CRYTALLOGRAPHY AND MINERALOGY

Battey, M.H., 1972, Mineralogy for students, Oliver & Boyd.
Berry, L.G. & Brian Mason, 1959, Mineralogy, Freeman.
Burger, M.J., 1963, Elements of Crystallography, Wiley.
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De Jong, W.F., 1955, General Crystallography, Freeman.
Donald Bless, F., 1961, Introduction to the Methods of Optical Crystallography, Holt, Reinhard & Winston.
Hinnawai, E.E., 1966, Methods in Chemical and Mineral Microscopy, Elsevier.
Hurbut, C.S., 1971, Dana's Manual of Mineralogy, 18th edn., John Wiley.
Kerr, P. F., 1959, Optical Mineralogy, McGraw Hill.
Naidu, P.R.J., 1967, Johnannsen's Optical Mineralogy. Allied publishers.
Naidu, P.R.J., 1958, Four Axis Universal Stage, Commercial Printing and Publishing House.
Philips, F.C., 1963, Introduction to Crystallography, Thomas Nelson.
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GEO 1C 03 -GEOSTATISTICS & GEOINFORMATICS

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Burrough, P.A. & McDonnell, R.A., Principles of Geographical Information System, Oxford Pub.
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Moroney, K.J., 1952, Facts from figures, Penguin.
Tarrytown, Geographic Information System for Geoscientists Modelling with GIS, Pergamon Press.

GEO 1C 04 MARINE GEOLOGY AND ATMOSPHERIC SCIENCES

Balkema, A.A., 2001, Descriptive Physical Oceanography, Balkema Publishers, Tokyo.
Beer, T, 1997, Environmental Oceanography, CRC Press, New York.
Dickinson, W.R. & Yarborough, H., Plate Tectonics and Hydrocarbon Accumulation,
Emery K O & B J Skinner, B.J., Mineral Deposits of the Deep Ocean Floor,
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GEO 2C 05- STRUCTURAL GEOLOGY & ENGINEERING GEOLOGY

Ball, G.G., 1993, Fundamental of Engineering Geology, Butterworths Pub., London.
Billings, M.P., 1974, Structural Geology, II edn., Prentice Hall.
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GEO2C 06 -QUATERNARY GEOLOGY & SEDIMENTOLOGY

Blatt, H., Middleton, G. & Murray, R., 1972, Origin of Sedimentary Rocks, Prentice Hall.
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MODEL QUESTION PAPERS

INSTRUCTIONS TO THE QUESTION PAPER SETTERS

1. Questions shall be set to i) Assess the knowledge acquired ii) Standard application of Knowledge iii) Application of knowledge in new situations iv) Critical evaluation of knowledge and v) The ability to synthesize knowledge.
2. He / she shall also submit an Answer key and a detailed scheme of valuation along with the question paper.
3. A question paper shall be a judicious mix of objective type, short answer type, short essay type/problem solving type and long essay type questions.
4. Different types of questions shall possess different marks to quantify their range as follows.

Sl. No.	Type of questions	Number of questions	Number of questions to be answered	Marks For each question	Total marks
1	Long essay type	4	2	6	12
2	One word or one sentence	8	6	1	6
3	Short answer type	8	6	2	12
4	Short essay/problem solving type	8	6	3	18
				Total marks	48

5. The question paper setters have to be careful and ensure that the questions should be asked from all modules following a uniform pattern.
6. The syllabus of each theory paper (both core & elective) has a total of 8 modules.
7. In the case of papers where there are two sections, care must be taken to ask the essay questions in such a way that internal choice is from one section so that the student will have to attend both sections.
8. The question paper setters are requested to submit the question paper with correct spelling especially the scientific terms. Mistakes can be minimized if the question papers are type set.
9. In the case of core courses and elective courses the same question paper pattern may be followed.
10. Standard of questions : While setting the questions , the question paper setter shall see that the questions are neither too easy nor too difficult and the grade of difficulty may be set as follows: Easy questions:20%; Average questions:60%; Difficult:20% .

Kannur,
30 , January 2014

Prof. K.Sreemathikutty,
Chairman ,
Board Of Studies in Geology(Cd)

KANNUR UNIVERSITY
I SEMESTER MSc PROGRAMME IN GEOLOGY

GEO 1C 01- GEOMORPHOLOGY & REMOTE SENSING

Time: 3 Hours **Max. Marks: 48**

I. Write essay on the following.
   a. Climatic influences on geomorphological changes and its implications.
   OR
   b. Morphometric analysis of drainage basins and their application.
   (1x6 = 6 Marks)

II. Write essay on the following.
   a. Hyperspectral remote sensing and its applications in geological studies.
   OR
   b. Electromagnetic radiation and its interactions with land and atmosphere with special reference to remote sensing. (1x 6 = 6 Marks)

III. Answer in one word or in one sentence for any ***six*** of the following.
   a. The first pioneer in quantitative analysis of drainage basin morphology is _____.
   b. The total number of stream segments of all order in a basin per perimeter of the basin is known as _____.
   c. In geomorphology relief is defines as:
   d. The system in which energy of operation comes from outside the system and moves across the system boundary is known as:
   e. _____is the study of the relationship between the earthquakes, active tectonics and individual faults of a region. Acronym of SLAR.
   f. The graphic record of temperature is known as_____.
   g. _____is the latest remote sensing satellite lounged by India.
   h. The important characteristics of an object that facilitate its identification using remote sensing is _____. (6x1 = 6 Marks)

IV. Write short note for any ***six*** of the following.
   a. Polar wandering.
   b. Coastal submergence.
   c. Mode of river load transportation.
   d. Role of water in slope development.
   e. Theory of catastrophism. Multispectral scanner.
   f. Spectral resolution.
   g. Microwave remote sensing.
   h. DIP. (6x2 = 12 Marks)

V. Write short essay on any ***six*** of the following.

a. Consuming plate boundaries.
b. Palaeomagnetism.
c. Base level and its significances.
d. Gradational geomorphic process.
e. Dynamic equilibrium concept. Satellite data for groundwater exploration.
f. Thermal scanners.
g. Geometrical parameters of aerial photographs.
h. Aerial photographs and photogrametry. (6 x3 = 18 Marks)

Kannur University
I Semester M.Sc. Programme in Geology
GEO1C02- Crystallography and Mineralogy

Time: Three hours Maximum: 48 Marks

Answer all questions

I. Write essay on the following

a. Write an essay on Napier's rule and its application in crystallography

Or

b. Discuss different types of projection methods and comment on Stereographic projections.

(1 x 6 =6 marks)

II. Write essay on the following

a. What is dispersion ? Discuss different types of dispersion in minerals..

Or

b. Give an account on the physical, chemical and optical properties of Pyroxene Group of minerals.

(1 x 6 =6 marks)

III. Answer in one word or one sentence on any ***six*** of the following:

a. Define Zone
b. What is Space lattice
c. What is operation of rotational symmetry
d. Retardation of mica plate
e. Which mineral is used in Berek Compensator?
f. Which crystallographic axis coincides with one of the vibration direction in monoclinic crystal
g. Structure of Feldspar
h. Hardness of Kyanite

(6 x 1 = 6 marks)

III. Short answer type on any **six** of the following

a. Axial ratio of Hexagonal system
b. Spherical Projection
c. Lattice Structure
d. Sign of elongation
e. BXa Figure
f. Metamictisation
g. Extinction in monoclinic crystal
h. Epidote

(6 x 2 = 12 marks)

IV. Short essay type on any **six** of the following

a. Gnomonic projection
b. X-ray Crystallography
c. Distinguish between feldspar and feldspathoid.
d. Uniaxial indiatrix
e. Basic principle of universal stage
f. Optic anomalies
g. Method of determination of 2 V
h. Clay mineral identification (6 x 3 = 18 marks)

KANNUR UNIVERSITY
I SEMESTER MSc PROGRAMME IN GEOLOGY

GEO 1C 03 GEOSTATISTICS & GEOINFORMATICS

Time: 3 Hours **Max. marks: 48**

I. Write essay on the following.

a. Define probability function. Explain binomial distribution and normal distribution stating their important properties.

OR

b. Discuss the different stages in a test hypothesis. Explain the method of testing the mean of a population based on a large sample. (1 x 6 = 6 Marks)

II. Write essay on the following

a. Various methods of spatial data interpolation and their applications in surface analysis.

OR

b. Error corrections in GPS and applications of GPS. (1 x 6 = 6 Marks)

III. Answer in one word or in one sentence for any ***six*** of the following.

a. The sum of observations divided by their number is known as_____.
b. What is variation or dispersion?
c. In a frequency distribution, symmetrical clustering of values around a central location is known as_____.
c. The process of finding value of the unknown function at a point which is outside the given points is known as _____.
d. What is time series forecasting?
e. 3D positioning using GPS is based on _____principle.
f. What is WAAS?
g. Collection of information that can describe objects and things with relation to space is known as _____. (6 x 1 = 6 Marks)

IV. Write short note for any ***six*** of the following.

a. Optimization.
b. Regression.
c. Quartiles.
d. Stratified sampling.
e. F test. UTM projection.
f. GLONASS.
g. 3D GIS.
h. Applications of viewshed analysis. (6 x 2 = 12 Marks)

III. Write short essay on any ***six*** of the following.

a. Coefficient of variation.
b. Skewness.
c. Multiple regression.
d. Cluster analysis.
e. Principle component analysis.
f. LIDAR.
g. Data compression.
h. Network analysis. (6 X 3 = 18 Marks)

Kannur University
I Semester M.Sc. Programme in Geology
GEO1C04- Marine Geology & Atmospheric Sciences

Time: Three hours Maximum: 48 Marks

Answer all questions

I a. Write an essay on marine sediments, their origin, distribution, classification

Or

b. Discuss the vertical distribution of temperature, pressure and density of seawater. (1 x 6 =6 marks)

II. a. Describe the process and formation of clouds and their classification

Or

b. Write an essay on role of CO_2 in climate changes. (1 x 6 =6 marks)

V. One word or one sentence on any **six** of the following:

a. Most abundant dissolved gases in sea water
b. pH of sea water
c. Indian navigation satellite system
d. JOIDES stands for
e. What is the polar height of Tropopause?
f. Time taken for the sunlight to reach earth surface
g. Which cloud contributing heavy rainfall ?
h. ITCZ stands for (6 x 1 = 6 marks)

VI. Short answer type on any **six** of the following

a. Cobalt crust
b. Tidal currents
c. CRZ
d. Challenger Expedition.
e. Hadley Cell
f. Coriolis Effect
g. Albedo
h. Hurricane (6 x 2 = 12 marks)

VII. Short essay type on any **six** of the following

a. Discuss Ocean as CO_2 sink
b. Thermo hyaline circulation
c. EEZ
d. Controls on the formation of manganese nodules
e. Cloud seeding
g. Monsoon winds reversal in the Indian Ocean
a. Westerlies and Easterlies
f. Kyoto Protocol (6 x 3 = 18 marks)

Kannur University
II Semester MSc Programme in Geology

GEO 2C 05 STRUCTURAL GEOLOGY & ENGINEERING GEOLOGY

Time: 3 hours **Marks: 48**

Answer all questions

I. a) Describe various types of lineation and its significance in interpreting tectonic history of a region.

Or

b) Give an account of the concept of stress and strain. Explain the behavior of minerals and rocks under deformation conditions. **(1 x 6 = 6 marks)**

II. a) Describe the engineering properties of rocks with suitable examples to illustrate them.

Or

b) Write as essay on coastal engineering. **(1 x 6 = 6 marks)**

III. Answer in one word or one sentence to any ***six*** of the following.

a) Throw of a fault . b) L-tectonites
c) Rock cleavage . d) Mylonites
e) Grouting . f) Factor of safety
g) Rock slides. h) RIS

(6 x 1 = 6 marks)

IV. Give short answers to any ***six*** of the following.

a) Rose diagrams
b) Columnar joints
c) Petrofabric diagrams
d) Conical folds
e) Forces acting on a dam
f) Hazard zonation mapping
g) Seepage in reservoirs
h) Rock water interaction **(6 x 2 = 12 marks)**

V. Write short essays on any ***six*** of the following.

a) Brittle ductile shear zones
b) Genetic classification of faults
c) Relationship of cleavage to folding
d) Determination of top and bottom of beds
e) Geological factors in tunnel construction
f) Engineering properties of soils
g) Foundation investigations for bridges
h) Terrain modeling **(6 x 3 = 18 marks)**

Kannur University
II Semester M.Sc. Programme in Geology
GEO2C06- Quaternary Geology and Sedimentology

Time: Three hours Maximum: 48 Marks

Answer all questions

I. a. What are proxies? Give examples for biological proxies for paleoclimatic reconstruction.

Or

b. Write an essay on environmental magnetism, principle and application in Quaternary studies. (1 x 6 =6 marks)

II. a. Discuss the processes of heavy mineral formation. Add a note on its separation and identification.

Or

b. Write an essay on tectonics and sedimentation. Add a note on sedimentary basins of India. (1 x 6 =6 marks)

III. One word or one sentence on any **six** of the following:

a. Tilt of earth axis
b. Time span of Quaternary
c. Stable isotopes of oxygen
d. Calendar age of HE1
e. Grain shape
f. Lithofacies
g. A stable mineral
h. Silt size (6 x 1 = 6 marks)

IV. Short answer type on any **six** of the following

a. LGM
b. Speleothem
c. Obliquity
d. Younger Dryas
e. Polymictic Conglomerate
f. Sedimentary textures
g. Estuarine environment
h. Graphical representation of grain size (6x2=12 marks)

V. Short essay type on any **six** of the following

a. Bond Cycles
b. Quaternary glaciations in India
c. Principle of Radiocarbon dating
d. Stable isotopes used for Quaternary studies
e. Provenance study
f. Grade scale
g. Secondary sedimentary structures
h. Diagenesis (6x3=18 marks)

Kannur University

II Semester M.Sc. Programme in Geology

GEO2E01 - Exploration Geology and Geophysics

Time: Three hours Maximum: 48 Marks

Answer all questions

I. a. Write an essay on Classification of Mineral Resources and Ore Reserves.

Or

b. Discuss the different Sampling techniques used for the exploration of mineral deposits. (1 x 6 =6 marks)

II. II. What is Bouger anomaly? Discuss different corrections in gravity survey.

Or

b. Write an essay on seismic survey and its importance in oil and natural gas exploration. (1 x 6 =6 marks)

II. One word or one sentence on any **six** of the following:

a. A topographic guide
b. Anomaly
c. A botanical indicator for gold deposits
d. Gossan
e. Sonic logging
f. Seismogram
g. Value of gravity
h. Geo-station (6 x 1 = 6 marks)

III. Short answer type on any **six** of the following

a. Rotary drilling
b. Underground mapping
c. Well logging
d. Water sampling techniques
e. Earth Magnetic field
f. Love waves
g. Seismic profiles
h. Terrain corrections (6 x 2 = 12marks)

IV. Short essay type on any **six** of the following

a. Geochemical guides
b. Borehole evaluation
c. Ore reserves estimation
d. Mobility of elements
e. Instruments for seismic study
f. Principles of magnetic survey
g. Ground water resistivity survey
h. Principles of Radiometric methods (6 x 3 = 18 marks)

Kannur University

III Semester MSc Programme in Geology

GEO 3C 07 – IGNEOUS & METAMORPHIC PETROLOGY

Time: 3 hours **Marks: 48**

Answer all questions

I. Write essay on the following

a) Describe the course of crystallization of a melt in the Diopside-Forsterite-Silica system.

Or

b) Discuss the mineralogy, classification and petrogenesis of lamprophyres.

(1 x 6 = 6 Marks)

II. Write essay on the following

a) Discuss the plate tectonics using paired metamorphic belts.

Or

b) Discuss the metamorphism of calcareous rocks **(1 x 6 = 6 Marks)**

III. Answer in one word or one sentence to any six of the following.

a) Norm b) Felsic rocks
c) Solid solution d) Differentiation index
e) Spinifex texture f) Skarn
g) Index mineral h) Idioblastic texture
i) Metasomatism j) Schisto **(6 x 1 = 6 Marks)**

IV. Give short answers to any six of the following.

a) Lunar rocks
b) CIPW classification
c) Pegmatites
d) Porphyritic texture
e) Tholeiitc basalts
f) AFM diagram
g) Metamorphic phase rule
h) Contact metamorphic rocks
i) Amphibolite
j) Barrowian zones **(6 x 2 = 12 Marks)**

IV. Write short essays on any six of the following.

a) Carbonatites
b) Larsen variation diagram
c) REE behavior in igneous rocks
d) Komatities
e) Bowen's Reaction principle
f) Retrograde metamorphism
g) Metamorphic textures
h) Metamorphic phase rule
i) Metamorphic facies
j) Classification and origin of migmatites **(6 x 3 = 18 Marks)**

KANNUR UNIVERSITY
I SEMESTER MSc PROGRAMME IN GEOLOGY

GEO 3C 08 STRATIGRAPHY & PALAEONTOLOGY

Time: 3 Hours **Max. Marks: 48**

I. Write essay on the following.

a. Concept of Gondwana land and its equivalents in other parts of the world.
OR
b. Precambrian mobile belts of India and its stratigraphic significances.

(1x 6 = 6Marks)

II. Write essay on the following

a. Palaeo ecology of foraminifera and their application in petroleum exploration.
OR
c. Evolution of life during Precambrian and its significances in stratigraphy.

(1x 6 = 6 Marks)

III. Answer in one word or in one sentence for any ***six*** of the following.

a. The principle of faunal succession is proposed by _____
b. The science of dating and determining the time sequence of the events in the history of the Earth is known as _____.
c. Dharwar Province and Southern Granulite Province are separated by _____.
d. A succession of schistose rocks in parts of Tellicherry taluk in Kannur district is described as _____.
e. Which was the first horse in the world?
f. The breathing organ of Pisces are known as _____.
g. The outermost bone of the foreleg is known as _____.
h. Study of organic microfossils are called as _____ (6 x 1 = 6 Marks)

IV. Write short note for any ***six*** of the following.

a. Stratigraphic procedures
b. Saline series
c. Stratigraphic principles of Steno.
d. Biostratigraphy.
e. Origin of Greenstone belts.
f. Morphology of Lepidodendron.
g. Extraterrestrial origin of life.
h. Extraction of micro fossils from sediments. (6 x 2 = 12 Marks)

V. Write short essay on any ***six*** of the following.

a. Precambrin mobile belt.
b. Vindhyan Supergroup.
c. Gondwana glaciations and its significances.
d. Granulites of Kerala.
e. Werner's contributions to stratigraphy.
f. Miller's experiment on origin of life.
g. Evolutionary trends of Trilobita.
h. Vertibrates in Siwalik Formation. (6 x 3 = 18 Marks)

Kannur University
III Semester MSc Programme in Geology

GEO 3C 09 – GEOCHEMISTRY & ISOTOPE GEOLOGY

Time: 3 hours **Marks: 48**

Answer all questions

I. Write essay on the following

a) Describe the principles and methods of analysis based on absorption and emission spectra.

Or

b) Explain the geochemical composition of crust, mantle and core of the earth.

(1 x 6 = 6 Marks)

II. Write essay on the following

a) Explain Rb-Sr method of age determination and its merits and demerits.

Or

b) Explain the significance of stable isotopes of Carbon, Oxygen and Sulphur in petrology.

(1 x 6 = 6 Marks)

III. Answer in one word or one sentence to any six of the following.

a) Redox potential b) Polymorphism
c) Solid solution d) Fugacity
e) Half-life period f) Carbon isotopes
g) Alpha particles h) Electron capture

(6 x 1 = 6 Marks)

IV. Give short answers to any six of the following.

a) Geochemical cycle
b) Mass spectrometer
c) Phase rule
d) Composition of meteorites
e) Fission track methods of dating
f) K-Ar systematics
g) Isotopic evolution of Nd
h) Single zircon dating method **(6 x 2 = 12 Marks)**

V. Write short essays on any six of the following.

a) XRD
b) Cosmic abundance of elements
c) Primary differentiation of elements
d) Geochemical classification of elements
e) Application of $\delta^{18}O$ in hydrogeology
f) Sm-Nd sytematics
g) C-14 dating method
h) Importance of Sr in the study of metamorphic rocks **(6 x 3 = 18 Marks)**

KANNUR UNIVERSITY
III SEMESTER MSc PROGRAMME IN GEOLOGY

GEO3E 04– ENVIRONMENTAL GEOLOGY

Time: 3 Hours **Max. marks: 48**

Answer all questions

I. Write essay on any two of following.
   a. Sources and impacts of Marine pollution.
   b. Methodology of EIA for dams.
   c. Causes and symptoms desertification. What are the prevention measures.
   d. Alternate energy sources for the future. (2x 6 = 12 Marks)

II. Answer in one word or in one sentence for any six of the following.
   a. The intensity of earthquake is measured by_____.
   b. Thermal energy generated and stored in the earth is known as_____.
   c. What are the 3'R's in waste management?
   d. Thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen is known as _____.
   e. The main toxic substance in Bhopal disaster was_____.
   f. EIA commenced in the year_____.
   g. Annual thinning of the ozone layer over Antartica caused by stratospheric chlorine is known as_____.
   i. What is the permissible limit of fluoride in drinking water?
   (6 x 1 = 6 Marks)

III. Write short note for any six of the following.
   a. Non renewable resources
   b. Geothermal energy
   c. Hazard zonation
   d. Radiactive waste
   e. Pyrolysis
   f. Ozone layer depletion
   g. Urbanization
   i. Public hearing in EIA. (6 x 2 = 12 Marks)

IV. Write short essay on any six of the following.

a. Resources of the ocean floor
b. Siesmic hazards and its impacts
c. Liquid waste management
d. Reservoir sedimentation
e. Acid mine drainage and groundwater pollution
f. Environmental geologic mapping
g. Primary and secondary environmental impacts
i. EIA in sustainable development. (6 x 3 = 18 Marks)

Kannur University
IV Semester MSc Programme in Geology

GEO 4C 12 HYDROGEOLOGY

Time: 3 hours **Marks: 48**

Answer all questions

I. Write essay on the following

a) Describe the hydrogeological properties of rocks

Or

b) Define Darcy's law. Explain the applications of Darcy's law in ground water studies.

(1 x 6 = 6 marks)

II. Write essay on the following

a) Explain pumping tests. Give an account of the methods of analyses of pumping test data.

Or

b) Describe the different methods of rainwater harvesting. **(1 x 6 = 6 marks)**

II. Answer in one word or one sentence to any six of the following.

a) Flownets
b) Hydraulic conductivity
c) Effective porosity
d) Drawdown
e) Piezometric surface
f) Aquitard
g) Leaky aquifer
h) Permeability **(6 x 1 = 6 marks)**

III. Give short answers to any six of the following.

a) Tidal efficiency
b) Artesian wells
c) Wenner method
d) Well casings
e) Jacob's method
f) Leaky aquifers
g) Fluid potential
h) Reynold's number **(6 x 2 = 12 marks)**

IV. Write short essays on any six of the following.
a) Ghyben-Herzberg relation
b) Hydrostratigraphic units
c) Elasticity of aquifers
d) Ground water management
e) Origin of ground water
f) Hydraulic budget
g) Stiff's polygon
h) National Water policy **(6 x 3 = 18 marks)**