UNIVERSITY OF CALICUT

Abstract

M.Sc. Programme in Applied Geology- Regulations, Scheme of Evaluation, and Syllabus- Teaching Department in the University(CCSS-PG)- implemented with effect from 2015 admissions-orders issued.

G & A - IV - J

U.O.No. 11121/2015/Admn Dated, Calicut University.P.O, 28.10.2015

Read:-1. U.O.No.GAI/J1/1373/08 dated 01.07.2008

2. Item No.5 in the minutes of the meeting of the Board of Studies in Geology, held on 26.05.2015
3. Item No.1 in the minutes of the meeting of the Faculty of Science held on 28.05.2015
4. Item No.II D in the minutes of the meeting of the Academic Council held on 11.07.2015
5. Circular No. 53986/GA - I - F 1/2015/Admn dated 04.08.2015

ORDER

As per paper read as (1) above, Choice based Credit Semester System at Post Graduate level in University Teaching Departments has been implemented from the academic year 2008-2009 onwards.

The Board of Studies in Geology resolved to entrust the Chairman to carry out the restructuring of the scheme and syllabus for MSc Applied Geology (CCSS- University Dept.), vide paper read as (2) and the syllabus prepared accordingly.

The Faculty of Science, vide paper read as (3), approved the resolution of the Board.

The Academic Council approved the same vide paper read as (4).

Vice-Chancellor vide paper read as (5) ordered to implement the decisions of the Academic Council.

Sanction has, therefore, been accorded for implementing the Regulations, Scheme of Evaluation, and Syllabus for M.Sc. Programme in Applied Geology for University Teaching Department (2015 Admission onwards) Under Choice Based Credit Semester System – CCSS.

Orders are issued accordingly.

The Regulations, Scheme of Evaluation, and Syllabus is available in the University website:www.universityofcalicut.info

Usha K
Deputy Registrar

To

The Department of Geology
Copy To: PS to VC/PA to Registrar/PA to CE/ Pareeksha Bhavan/ Board of Studies in Geology

Forwarded / By Order

Section Officer

Regulations, Scheme of Evaluation, and Syllabus for

Master of Science (M.Sc.) Programme

in

Applied Geology

for University Teaching Department

(2015 Admission onwards)

Under

Choice Based Credit Semester System – CCSS

UNIVERSITY OF CALICUT

Board of Studies in Geology (UG & PG Combined)
University of Calicut
June 2015

The existing regulations of Choice-based Credit Semester System (UO No. GA1/J1/1373/2008 Dated 01-07-2008), which are applicable for University Teaching Departments are applicable for this Programme.

1. Eligibility Criteria

Those students who possess B.Sc. Degree in Geology, Geology & Water Management as Core Courses with Physics/Chemistry/Statistics/Remote Sensing & GIS/Mathematics as Complementary courses with at least 60% marks (or equivalent grades) are eligible for admission to this programme.

2. Scheme of Examinations

1) The duration of the M.Sc. (Applied Geology) programme shall be 2 years, split into 4 semesters.

2) There shall be external university examination of 3 hour duration for each theory courses at the end of the each semester, to be conducted after the completion of 90 working days.

3) Practical examinations and viva-voce shall be conducted by the university at the end of even semesters. Each practical examination is of 4 hour duration.

4) Each theory and practical course shall have 4 credits and viva-voce shall have 2 credits.

5) Project/dissertation and combined field mapping shall carry 4 credits each. Combined field mapping may be carried out at any time during the entire period of the programme.

6) Apart from the fieldwork carried out as part of project/dissertation and combined field mapping, study tour/field studies on different geological formations across the country, extending about two- to three-weeks forms an integral part of the programme. This may be carried out as one stretch or two-stretches within the first two semesters of the programme.

7) Combined field mapping and Project/dissertation evaluation shall be conducted by external examination at the end of the programme only.

8) Each theory question paper may contain 14 short answer types, of weightage 1, 7 short essays out of 10 of weightage 2, and 2 long essays out of 4, of weightage 4.

3. Credits and marks for various papers, and evaluation scheme

Semester	Course Type	Course Code	Course Title	Credits	Max Marks		
					Internal	External	Total
I	Theory	GEL 1C 01	Physical Geology & Geomorphology	4	20	80	100
	Theory	GEL 1C 02	Structural Geology & Geotectonics	4	20	80	100

	Theory	GEL 1C 03	Stratigraphy & Applied Palaeontology	4	20	80	100
	Practical*	GEL 1C 04P	Geomorphology, Structural Geology, Applied Palaeontology	4	20	80	100
II	Theory	GEL 2C 05	Crystallography & Mineralogy	4	20	80	100
	Theory	GEL 2C 06	Applied Geology & Marine Geology	4	20	80	100
	Theory	GEL 2C 07	Hydrogeology	4	20	80	100
	Practical	GEL 2C 08P	Crystallography, Mineralogy, Hydrogeology, and Applied Geology	4	20	80	100
	Study tour/ Fieldwork††	GEL 2C 09Fw	Study Tour/Fieldwork Report	4	20	80	100
	Viva-Voce	GEL 2C 10V	Viva-Voce	2	10	40	50
III	Theory	GEL 3C 11	Exploration Geology & Applied Geophysics	4	20	80	100
	Theory	GEL 3C 12	Igneous and Metamorphic Petrology	4	20	80	100
	Elective#	GEL 3E 01	Remote Sensing & Geographic Information System	4	20	80	100
		GEL 3E 02	Climatology				
		GEL 3E 03	Seismology				
	*Practical	GEL 3C 13P	Exploration Geology, Geophysics, Igneous and Metamorphic Petrology	4	20	80	100
IV	Theory	GEL 4C 14	Economic Geology	4	20	80	100
	Theory	GEL 4C 15	Geochemistry & Sedimentology	4	20	80	100
	Elective#	GEL 4E 04	Environmental Geology	4	20	80	100
		GEL 4E 05	Disaster Management				
		GEL 4E 06	Geotechnical Engineering				
	Practical	GEL 4C 16P	Economic Geology, Geochemistry, and Sedimentology	4	20	80	100
	Project / Dissertation±	GEL 4C 17Pr	Project/Dissertation	4	20	80	100
	Field Mapping†	GEL 4C 18Mp	Combined Field Mapping	4	20	80	100
	Viva-Voce	GEL 4C 19V	Viva-Voce	2	10	40	50
			Total for the programme	**80**	**400**	**1600**	**2000**

*Exam will be held at the end of even semesters.

††Fieldwork extending for two- to three-weeks may be carried out within first and/or second semester(s).

#An institution can offer any one among these courses.

±The project work may start after first semester of the programme, however, evaluation will be held at the end of 4thsemester.

†Evaluation of the combined field mapping camp will be held at 4th semester of the programme.

4. Evaluation

The evaluation scheme for each course shall contain two parts (a) Internal evaluation and (b) external evaluation. A total of 100 mark is fixed for theory, practical, project/dissertation, field mapping, and study tour/fieldwork and 50 for viva-voce. Out of these, 20% marks shall be given to internal evaluation and the remaining 80% to external evaluation.

4.1. Internal evaluation

The internal evaluation shall be based on predetermined transparent system. The internal evaluation will be based on periodic written tests, assignments, seminars and attendance in the case of theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The internal evaluation of combined field mapping and study tour/fieldwork will be based on punctuality, fieldwork skill/ability in recording geological parameters, specimen collection and viva. The marks assigned to various components for internal evaluation is as follows:

4.1.1. Components of internal evaluation

Sl. No.	Component	Marks
i)	Attendance	4
ii)	Assignment	4
iii)	Seminar	4
iv)	Test paper	8
	Total	20

4.1.1.1. Percentage of attendance and eligible marks

% of attendance	Max. Marks
Above 95%	4
86-95%	3
76-85%	2
75%	1

4.1.1.2. Project/Study Tour

Sl. No.	Criteria	Marks
1.	Punctuality& Field Note	3
2.	Field work/Skill	3
3.	Specimen collection/preparation of map	6
4.	Viva-voce	8
	Total	**20**

4.2. External evaluation

The external examination in theory courses is to be conducted by the University with question papers set by external experts from other Universities. The evaluation of the answer scripts shall be done by external examiners based on a well-defined scheme of valuation. The external evaluation shall be done immediately after the examination in a Centralized Valuation Camp.

Photocopies of the answer scripts of the external examination shall be made available to the students for scrutiny on request and revaluation/scrutiny of answer scripts shall be done as per the existing rules prevailing in the University. Awarding of a higher grade after revaluation may be given only after a second revaluation:

4.3. Minimum requirements for the successful completion of the programme

Pass Minimum for External Examinations = 50%

No pass minimum for Internal Examination.

Pass Minimum for a Course : C Grade

Semester Grade Point Average (SGPA) = $\frac{\text{Sum of Credit points Secured in a semester}}{\text{Sum of Credits Taken in the Semester}}$

Minimum SGPA for the Successful Completion of a Semester : 5.00

Minimum CGPA for the Successful Completion of a Programme : 5.00

Cumulative GRADE Point Average (CGPA) = $\frac{\text{Sum of Credit points Secured in a Programme}}{\text{Sum of Credits Taken in the Programme}}$

Note : SGPA includes all courses (papers) taken by the candidate in that semester including the courses taken over and above the prescribed credits. For the CGPA computation only the best performed courses with maximum credit points (P) alone shall be taken subject to the restrictions on the minimum prescribed credits of elective courses for passing a specific degree.

CORE COURSE: THEORY SYLLABUS

GEL 1C 01 - PHYSICAL GEOLOGY AND GEOMORPHOLOGY

Credits: 4

Module 1:

- Earth and the solar system; Meteorites and other extra-terrestrial materials; Planetary evolution of the earth; Heterogeneity of the earth's crust; Major tectonic features of the Oceanic and Continental crust.
- The earth's magnetic field; Magnetic anomalies; Magnetic reversals; Heat within the earth; Geothermal gradient; Heat flow.

Module 2:

- Gravity measurements; Positive and negative gravity anomalies; Geoid; spheroid; Isostasy.
- Basic concepts of seismology and internal structure of the earth; Physico-chemical and seismic properties of the earth's interior; Modern techniques for prediction of earthquakes.

Module 3:

- Geomorphic principles and processes; Theory of uniformitarianism; Control of geomorphological features by geologic structures, lithology, climate and time; Geomorphologic cycles; Models of landscape evolution.
- Streams-stream hydraulics; Drainage basin; Morphometric analysis of drainage basins; Fluvial, denudational and erosional landforms; Concept of rejuvenation and interruptions in the evolution of land.
- Coastal Geomorphology. Landforms of wave erosion and deposition. Beach Profiling

Module 4:

- Wetlands– Geological significance, classification and mode of formation; Indian scenario; Conservation and management in India; Backwaters (Kayals) of Kerala.
- Soils– formation and classification; soil profile; soils of Kerala.
- Geomorphology of Kerala– classification, relief features, geological significance; Rivers of Kerala; Geomorphic features of the Indian subcontinent

Module 5:

- Hill slopes– forms in relation to lithology and structural weakness in rocks; control and mass movement; modification by overland flow of hill slopes; Slope stability
- Applications of Geomorphology in Civil Engineering, Hydrogeology, and Environmental Studies.

Essential Reading:

1. Ahamed, E., 1972. *Coastal Geomorphology of India*. Orient Longman, New Delhi.
2. Bloom, A., Geomorphology, CBS, New Delhi
3. Cox. A. Plate tectonics and geomagnetic reversals, Freeman, 1973

4. Eicher.L.D., Geologic Time, Prentice Hall, 1968
5. Fowler, C. M. R., The solid Earth; An introduction to global geophysics,Cambridge University Press, 1990
6. Hamilton, E. I., Applied geochronology, Academic Press, 1965
7. Hart M.G., Geomorphology-Pure and applied, Allen & Unwin, London. 1986
8. Holmes, A. Principles of Physical Geology, Ronald, London, 1972
9. Hudson, T., 2012. *Living with Earth – An Introduction to Environmental Geology*. Pearson Education Inc., New Jersey, USA.
10. Jacobs,J.A., Russel, R.D., and Wilson, J.T., Physics and Geology, Wiley Eastern.
11. King, C.A.M. Beaches and Coasts, Arnold, London, 1972
12. Leopold, L. Wolmen, C. and Miller J.P. Fluvial processes in Geomorphology, EPH Publishing House, New Delhi, 1976
13. Pethick, J., An introduction to coastal geomorphology, Arnold Heinman publishers, (India), New Delhi, 1984
14. Rice,R. J., Fundamentals of Geomorphology, ELBS, Longman,1990
15. Schumm, S .A. (Ed), Drainage Basin morphology- In Bench mark papers in Geology
16. Shartna, H. S.s Indian geomorphology, Concept Publishing .Co, New Delhi, 1990
17. Thombury, W.D. Principles of Geomorphology, Wiley, 1968
18. Windley, B.F., The evolving continents, John Wiley,& Sons

GEL 1C 02 - STRUCTURAL GEOLOGY AND GEOTECTONICS

Credits: 4

Module 1:

- Principles of geological mapping and map reading, projection diagrams. Stress-strain relationships of elastic, plastic and viscous materials. Measurement of strain in deformed rocks. Behaviour of minerals and rocks under deformation conditions. Stress and Strain diagrams.
- Folds - Geometric classification after Ramsay, Genetic classification after Donath and Parker. Plunging folds, cylindrical folds, minor folds and their uses in determining the major fold structure. Pumpelley's rule. Mechanics of folding. Superposed folding and interference patterns.

Module 2:

- Faults and fractures - Brittle and shear failure, Mohr circle, fault geometry and nomenclature. Features of fault planes and fragmental rocks produced by faulting.
- Deep fractures. Joints, analysis of fractures. Ductile shear zone. Stress and strain ellipsoids and their use in the study of faults and joints.

Module 3:

- Tectonites - classification, tectonic fabric. Foliation - axial plane foliation and its origin, fracture cleavages, crenulation cleavage and transposed foliation. Use of axial - plane foliation and fracture cleavages in the determination of major structures. Lineation: types, classification and origin.
- Geologic bodies and scale and structural co-ordinates. Fundamentals of geometric analysis. Stereographic and equal area projections in structural geology and diagrams. Geometric analysis of folds and lineations. Concept of petrofabric, use of Universal stage in fabric studies, fabric symmetry.

Module 4:

- Continental drift – geological and geophysical evidence, mechanics, objections, present status.
- Gravity and magnetic anomalies at Mid-ocean ridges, deep sea trenches, continental shield areas and mountain chains. Palaeomagnetism. Seafloor spreading

Module 5:

- Plate Tectonics- Different types of Plate margins; Island arcs, Oceanic islands and volcanic arcs; Orogeny and epeirogeny
- Seismic belts of the earth. Seismicity and plate movements. Geodynamics of the Indian plate

Essential Reading:

1. Billings, M.P. Structural Geology, II Edition, Prentice Hall, 1974
2. Hills, E.S. Elements of Structural Geology, 1 Edn. Asia Publishing House, 1965
3. Hobbs, B.E. Means. W.D, and William P.F. An outline of Structural Geology, John Wiley, 1976
4. John. I Roberts, Introduction to Geological Maps and Structures, Pergamon Press.
5. Ken MeClay The mapping of geological structures, Geological Society of London, John Wiley and Sons.
6. Philips, l'.C. Stereoscopic projection in Structural Geology, II Edn. Arnold, I960
7. Ragan, T.M. Structural Geology, I Edn. Wiley, 1963
8. Robert, J. Twiss and Eldridge, M. Moors, Structural Geology, W. H. Freeman and company, New York
9. Spencer, E. P. Introduction to the structure of the Earth, I Edn. McGraw Hill, 1969
10. Turner, F.J. and Weiss, L.E. Structural Analysis of Metamorphic Tectonics, IEdn. McGraw Hill, 1963
11. Whitten, E.H.T. Structural Geology of folded rocks, II Edn.

GEL 1C 03 - STRATIGRAPHY AND APPLIED PALAEONTOLOGY

Credits: 4

Module 1:

- Stratigraphic principles and evolution. Contributions of Steno, Lehmann, Fushel, Werner, Hutton, Lyell and Smith. Stratigraphic procedures-surface and subsurface procedures.
- Elements of Magnetostratigraphy, cyclostratigraphy, pedostratigraphy, chemostratigraphy and sequence stratigraphy.
- Major geological events during the different periods of earth history. Mass extinction - Meteoric impact Theory - Volcanic eruption theory

Module 2:

- Pre-Cambrian stratigraphy. Classification of Indian Pre-Cambrian with particular reference to Karanataka and Kerala. Greenstone belts and granulites of South India. Classification, lithology, ages, correlation of Sargur schist, Dharwar Supergroup, Cuddapah Supergroup and Vindhyan Supergroups.
- Stratigraphic boundary problems with reference to Indian subcontinent – Vindhyan, Saline Series and Deccan Traps.

Module 3:

- Fossils and fossilisation Definition and morphology. Modes of preservation and geometry of fossils. Physico- chemical conditions of fossilisation. Significance of fossils in Chronostratigraphy, Biostraligraphy, correlation. Palaeogeography, Palaeoecology and Palaeoclimate.
- Origin of life - Introduction - Extraterrestrial origin Terrestrial origin Early evolution of life - fossil records Modern concepts Theories of chemical basis of origin Miller's experiment - Theories of organic evolution.

Module 4:

- Evolution histories of Dinosaurs, Equus, Elephus and Man.
- Morphology, classification, evolutionary trends, palaeoecology and stratigraphic origin of the following groups - Brachiopoda, Pelecypoda, Cephalopoda, Trilobita, Graptolites and Stromatolites

Module 5:

- Micropalaeontology - Scope and classification of microfossils. Techniques in collection, separation, preparation and preservation of microfossils including palynofossils. General morphology of spores and pollens – their classifications.
- Classification, morphology, ecology, palaeoecology and stratigraphic importance of the following -Foraminifera, Ostracoda, Bryozoa and Conodonts.Application of microfossils in the petroleum exploration

Essential Reading:

1. Ager, D.V., Principles of Palaeontology, McGraw Hill, 1963
2. Arkell, W. J., Jurassic Geology of the World, Oliver and Boyd, 1960
3. Brouwer A., General Palaeontology. Olier and Boyd, 1967
4. Colebert H. Edwin, Evolution of the vertebrates, John Wiley and Sons, 1961
5. Cushman A. Joseph, Foraminifera, Harvvard University Press, 1959
6. Dalrymple,B.G ,and Lamphere, M. A., Potassium-Argon Dating, 1 Edn., Freeman, 1969
7. Dunbar, CO., and Rogers, J., Principles of Stratigraphy, Wiley, 1961
8. Easton, W.H. Invertebrate Palaeontology, Harper and Brother, I960
9. Eicher L.D., Geologic Time, Prentice Hall, 1968
10. Flint, R.F., Glacial and Pleistocene Geology, Wiley, 1961
11. G.H.B von Koenigswald, J.D. Ernies W.L Buning C. W. Wange (Editors), Evolutionary Trends in Foraminifera, Elsevier, 1963
12. Gignoux M., Stratigraphic Geology, Freeman, 1960
13. Glaesnewr, M.F. Principles of Micro Palaeontology, McGraw Hill, 1953
14. Gupta V.J., Cenozoic Stratigraphy of India, Hindustan Publishing House, 1975
15. Gupta V.J., Mesozoic Stratigraphy of India, Hindustan Publishing House, 1976
16. Gupta V.J., Precambrian Stratigraphy of India, Hindustan Publishing House, 1977
17. Hamilton, E. I., Applied Geochronoiogy, I Edn., Academic Press, 1965
18. John J. Daniel, Introduction to Microfossils, Harper and Brothers, 1956
19. Key and Colbert, Stratigraphy and Life History, Wiley, 1965
20. Krishnan, M.S., Geology of India and Burma, Higgin Bothams, 1968
21. Kruinbein, W.C., and Sloss L. D., Stratigraphy and Sedimentation, Freeman, 1963
22. Moore R.C., Lalicker C.G., Fisher A.G., Invertebrate Fossils, McGraw Hill, 1952
23. Moore R.C., An introduction to Historical Geology, McGraw Hill, 1958
24. Noa Version, Stratigraphic Principles of Palaeontology, Oxford University Press, 1952
25. Pichamuthu, C. S., Archaean Geology, Oxford I.B.B., 1985
26. Romer A.S., Vertebrate Palaeontology, Chicago University Press, 1966
27. Sarkar, S. N., Stratigraphy and Geochronoiogy of Peninsular India, I Edn., Dhanbad Publications, 1968
28. Shrock R.R., Berk Twenhofel W.H. Principles of Invertebrate Palaeontology, McGraw Hill, 1953
29. Swinnerton, H.H. Outlines of Palaeontology, Edward Arnold Ltd., 1961
30. Weller, Stratigraphic Principles and Practice, Harper and Row, 1959
31. Windley, B. F., The Evolving Continents, I Edn., John Wiley, 1977
32. Woods Henry, Invertebrate Palaeontology, Cambridge University Press, 1961
33. Zittel Karl A. Von, Text Book of Palaeontology, Parts I and II, McMillan, 1964.

GEL 2C 05 - CRYSTALLOGRAPHY AND MINERALOGY

Credits: 4

Module 1:

- Crystallography-Crystalline state-Repetition theory. Translation periodicity of crystals. Basic rotational symmetries and possibility of simultaneous rotational symmetries in different directions of crystals-symmetrical plane and symmetrical lattices.
- Derivation of 32 crystal classes. Stereographic projection of crystals.

Module 2:

- Crystal notation- Schoenflies notation. Herman Mauguin symbols-comparison between Schoenflies and International notations. Calculation of crystal elements to test the knowledge of the application of tangent relation, anharmonic ratios, Napier's theorem and equation of the normal.
- X-ray diffraction method- basic principles. X-ray diffractometer- Powder methods-Bragg‘s law and its application- Calculation of cell dimensions-identification of minerals from X-ray diffraction patterns.

Module 3:

- Optical mineralogy. Refractive index. Isotropic and anisotropic minerals. Interference of light waves- passage of light through doubly refracting minerals. Birefringence. Plane polarized and cross polarized light. Orientations of nicol prisms of a Petrological Microscope. Pleochroism and scheme of pleochroism.
- Uniaxial & biaxial minerals; uniaxial & biaxial indicatrices. Orientationof indicatrices. Generation of interference colours. Finding the order of interference colours.

Module 4:

- Optical accessories –construction and uses of Gypsum Plate, Mica Plate quartz wedge.
- Conoscopic study – Formation of interference figures. Uniaxial and biaxial interference figures. Determination of the Optic sign of uniaxial and biaxial minerals
- Vibration directions and sign of elongation in minerals. Extinction and extinction angle. Determination of Optic axial angle (2V).Dispersion and types of dispersion.

Module 5:

- Isomorphism, Polymorphism and the types. Different types of bonding in minerals and their significance. Solid solution and exsolution. Mineralogical expression of radioactivity- Metamictisation and pleochroic haloes.

- Structure and classification of Silicates. Distinctive physical, chemical and optical characters of the following mineral groups: Olivine, garnet, aluminosilicates, pyroxenes, amphiboles, mica, clay minerals, feldspars, feldspathoids, zeolites and silica group.

Essential Reading:

1. Burger, M.J., Elements of Crystallography, Wiley, 1963
2. De Jong,W.F., General Crystallography, Freeman ,1955
3. Bloss, D:F., Introduction to the methods of optical crystallography, Holt, Reinhart and Winston, 1961
4. Battey, M. H., Mineralogy for students, Oliver and Boyd, Edinburgh, 1972
5. Berry, L.G, Mason,B and Deitrich Mineralogy, 1976
6. Berry, L.G., Brian Mason, Mineralogy, Freeman, 1959
7. Dana, E. S., Text Book of Mineralogy Revised by Ford, Wiley, 1962
8. Deer, W. A., Howie, R. A., and Zussman, J., Rock forming minerals. Vol. 1-5,Longman, London, 1962
9. Hinnavvai, E. E., Methods in Chemical and Mineral Microscopy, Elsevier, 1966
10. 10. Hurbut, C. S., Dana's Manual of Mineralogy, John Wiley, I8"1 Edition, 1971
11. 11. Kerr,P.F., Optical mineralogy, Me Graw Hill,1959.
12. Mason, B., Principles of geochemistry, Wiley Toppan, Tokyo, Japan
13. Mitra, S., Fundamentals of Optical, Spectroscopic and X-ray mineralogy,Wiley Eastern, Ltd, NewDelhi,
14. Naidu, P. R. J., Johansen, Optical Mineralogy, Allied Publishers, 1967
15. Naidu, P.R.J., Four axes.universal stage, Commercial printing and Publishing house, Madras, 1985
16. Philips, F. C, Introduction to Crystallography, Thomas Nelson, 1963
17. Philips, W.R., Mineral Optics-Principles and techniques,Freeman, 1971.
18. Putins. A., Introduction to mineral sciences. Cambridge University Press 1992
19. Sinkankas, J., Mineralogy, East West Edition, 1959
20. Tutton. V I:. II., Crystallography and Practical crystal Measurements. Vol. 1, Today and tomorrow. .1965. '
21. Velde. B (Ed).. (Origin and mineralogy of clays, Springer-Verlag, 1995.
22. Wahlstrom, E E.. Optical Crystallography, Wiley. 1962
23. Wenk, H. R. (Ed), Electron microscope in mineralogy. Springer-Verlag,Newyork, 1976
24. Williams, K. L., Introduction to X-ray spectrometry, CBS Publishers and distributors, New Del hi-1987
25. Winchell, A.N., Elements of Optical mineralogy, Part I,Wiley,l951.

GEL 2C 06 - APPLIED GEOLOGY AND MARINE GEOLOGY

Credits: 4

Module 1:

- Mining methods - Alluvial mining-river sand mining, Mining of beach placers, Clay mining, Coal mining, Seabed mining, Exploration of petroleum.
- Fundamentals of ore dressing crushing, grinding, sizing, concentration by washing, scrubbing, jigging, tabling, floatation, magnetic and electrostatic separation.

Module 2:

- Engineering Geology - Role of Geology in civil engineering, engineering properties of rocks and soil, rock as building material, dimension and decorative stones, aggregates.
- Dams classification, foundation, abutment and reservoir problems. Geologic aspects of dam investigation. Tunnels - classification, geologic factors in tunnels. Landslides - types, causes and preventions. Stability of slopes. Aseismic design of buildings influence of geologic conditions on foundations and design of buildings.

Module 3:

- History of Marine geological studies-contribution of Challenger Expedition.
- Physical properties of sea water: distribution of temperature, pressure and density. Chemical properties of sea water-elements and dissolved gases present in sea water. Salinity and distribution of salinity.

Module 4:

- Coastal processes: waves, currents and tides. Coastal geomorphology, classification of coasts; Coastal erosion. Coastal protection structures -seawalls, jetties, groins. Coastal Regulatory zone (CRZ).
- Continental margin: features of continental shelf, continental slope and continental rise.

Module 5:

- Sea bottom topography- Submarine canyons, trenches, volcanoes, mid-oceanic ridges and abyssal plains.
- Marine Mineral resources: Controlling factors and distribution. Eustatic changes of sea level: evidences and implications.
- Marine sediments: Distribution and classification. Plate tectonics in relation to origin of the ocean basins

Essential Reading:

1. Compton, R. R., Manual of Field Geology, John Wiley
2. Reedman, J. K, Techniques in Mineral Exploration, Allied Scientific Publishers
3. Arogyaswamy, R. N. F., Courses in Mining Geology, Oxford and IBH Pub. Co.
4. Fox, Engineering Geology
5. Peters, W. C, Exploration and Mining Geology, John Wiley
6. Krynine and Judd, Principle of Engineering Geology and Geotectonic, McGraw Hill. 1957
7. Rose, A. W., Hawkes, H. F., and Webb, J. S., Geochemistry in Mineral Exploration, Academic Press
8. John, L. Mero, Oceanic Mineral resources
9. Keith S.Stowe, Ocean Science. John Wiley and Sons
10. Kenneth, J.P., Marine Geology, Prentice Hall Inc., 1982
11. Moore. T.C, and Health. G. R., Sea-floor sampling techniques
12. Seibold, E., and Berger, W.H., The sea floor. Springer-Verlag, 1982
13. Shepard, F. P., Submarine Geology
14. Sverdrup, H. V., et al, The Ocean
15. Fading, D. H., palaeomagnetism, Chapman and Hall, London, 1983
16. Trask, P. D., Recent Marine sediments, Dover publications, 1939
17. Weisberg, J., and Parish, R, Introductory Oceanography. .McGraw Hill, 1974
18. William, L. Donn, Meteorology
19. Yasso, W. E., Oceanography

GEL 2C 07 - HYDROGEOLOGY

Credits: 4

Module 1:

- Origin of water: meteroic, juvenile, magmatic and sea waters, Hydrologic cycle: precipitation, runoff, infiltration and evapotranspiration, Hydrographs.
- Subsurface movement and vertical distribution of groundwater, Springs. Classification of aquifers. Concepts of drainage basin and groundwater basin.
- Hydrological properties of rocks – specific yield, specific retention, porosity, hydraulic conductivity, transmissivity, storage coefficient. Determination of permeability in laboratory and in field. Water table fluctuations – causative factors, concept of barometric and tidal efficiencies. Water table contour maps.

Module 2:

- Theory of groundwater flow. Forces causing ground water movements. Darcy's Law and its applications.
- Unconfined, confined, steady, unsteady and radial flow conditions. Pump tests – methods, data analysis and interpretation for hydrogeologic boundaries. Evaluation of aquifer parameters using Thiem, Theis, Jacob and Walton methods.

Module 3:

- Groundwater quality – physical and chemical properties of water. Quality criteria for different uses - domestic, irrigation and industrial. Graphical presentation of water quality data - Stiff diagram, Pie diagram, Piper's trilinear diagram nd USSL diagram.
- Problems of arsenic and fluoride in groundwater. Saline water intrusion in coastal and other aquifers. Ghyben-Herzberg relation. Prevention and control of saline water intrusion. Radioisotopes in hydrogeological studies

Module 4:

- Ground water exploration -Geologic and hydrogeologic methods. Surface geophysical methods –electrical resistivity method: Wenner and Schlumberger configurations for vertical electrical sounding.
- Subsurface geophysical methods – well logging for delineation of aquifers. Remote sensing for groundwater exploration - hydrogeomorphic mapping of the terrain using different images of different satellite missions, lineament mapping, shallow groundwater potential zone mapping using satellite images.

Module 5:

- Types of wells, drilling methods, construction, design, development and maintenance of wells, specific capacity and its determination.
- Groundwater problems related to foundation work, mining, canals and tunnels. Problems of over exploitation and groundwater mining. Groundwater development in urban areas and rain water harvesting, artificial recharge methods.
- Groundwater provinces of India

Essential Reading:

1. Bouwer,H Groundwater Hydrology. 1978
2. Davies and De Wiest, Hydrogeology, John Wiley and Sons, 1966
3. Dominico, P. A.. Concepts and models in Groundwater Hydrogeology, McGrawHill
4. Fletcher, G. Driscoll, Groundwater and wells, Science Publ., Jodhpur, 1986
5. Karanth, K. R., Groundwatcr and wells, Science Publ., Jodhpur, 1986
6. Linsley, R. K., Jkohler, M. A., and Paulhus, J. L. H., Applied Hydrology, Tata McGrawHill, 1975
7. Raghunath, H. M., Groundwater, Wiley Eastern, 1987
8. Todd, D. K., Groundwater Hydrology, John Wiley and Sons, 1980
9. Tolman, C. F., Groundwater, McGraw Hill
10. Walton, W. C, Groundwater Resource Evaluation, McGraw Hill, 1970
11. Freeze and Cherry – Groundwater.

GEL 3C 11 - EXPLORATION GEOLOGY AND APPLIED GEOPHYSICS

Credits: 4

Module 1:

- Methods of surface and subsurface exploration. Prospecting for economic minerals. Drilling and its types.
- Different methods of sampling and assaying. Methods of ore reserve estimation.

Module 2:

- Geochemical exploration techniques. Mobility of elements, pathfinder elements, threshold values and geochemical anomalies. Mode of occurrence of trace elements. Primary dispersion pattern of deep-seated origin. Diffusion and leakage anomalies.
- Geochemical surveys, principles and methods of sampling. Anomalies in ground and surface waters and sediments. Biochemical anomalies. Geobotanical survey techniques. Geobotanical indicators.

Module 3:

- Geophysical exploration - Principles, scope, chief methods and their application.
- Electrical methods - principles, instruments used. Self-potential methods, resistivity method Application in ground water exploration

Module 4:

- Gravity methods - Density and rock types, correlation of gravity data, regional and local anomalies.Sample interpretation, instrument used -gravimeter. Magnetic methods - field procedure, magnetometer, interpretation of magnetic data, correlations and applications. Principles of air borne survey.
- Seismic method- Seismic waves, travel velocity in various geological formations – Principles Field operations. Refraction and reflection survey - correction of seismic data - methods if interpretation -determination of attitude and depth of formation. Various types of shooting. Seismic instruments and records.

Module 5:

- Radiometric methods principles of radioactivity, methods, types of counters: G.M. counters and Scintilometers. Field methods and interpretations.
- Geophysical well logging Electrical, radiometric, sonic and thermal logging of boreholes

Essential Reading:

1. Compton.R.R., Manual of Field Geology, John Wiley

2. Dobrin M.B, Introduction to Geophysical Prospecting, Pergamon Press
3. Elements of Prospecting and Exploration, Kalyan Publishers
4. Ginzburg, I., Principles ofGeochefnical prospecting, Pergamon Press
5. Griflithis, D. and Kind, R. F., Applied Geophysics for Geologists and Engineers, Pergamon Press
6. Kovalarkim, Biochemical exploration for mineral deposits Co-Xinian Press
7. Lahee, F. H., Field Geology, Mc Graw Hill
8. Low, G.W., Geological Field Methods, Harper and brothers
9. Malyyuga,D.F.,Biochemical methods of prospecting, Consultants Bureau,NewYork
10. Reedman, J. H., Techniques in Mineral Exploration, Allied Scientific Publishers
11. Sinha, R. K.., and Sharma, N. L, Mineral Economics, Oxford and I.B.H. – Publishers

GEL 3C 12 - IGNEOUS AND METAMORPHIC PETROLOGY

Credits: 4

Module 1:

- Bowen's reaction principle and reaction series. Major, minor, trace and rare earth element geochemistry of igneous rocks. Significance of isotopic studies in the petrogenesis of igneous rocks.
- Igneous process and diversity in igneous rocks. Compositional variation in magmas.
- Genetic significance of the textures and structures of the igneous rocks.
- Phase rule and its application in the study of silicate systems - phase diagrams, primary phase diagrams and liquidus projections.

Module 2:

- Equilibrium crystallization and melting paths in igneous systems.
- Phase diagrams- Unary, binary, ternary and quaternary diagrams.
- Study of the course of crystallization of the following chemical systems: Binary systems: Fo-Fa, Ab-An, Di-An, Di-Ab and Fo–Si; Ternary systems: Forsterite-Diopside-Silica, Diopside-Anorthite-Silica, Diopside-Anorthite-Albite, Albite-Anorthite-Orthoclase, MgO-Al_2O_3-SiO_2.

Module 3:

- Classification of igneous rocks- Shand , Streckeisen and CIPW Mode and Norm . Variation diagrams.
- Petrogeny's residua system. Differentiation index.
- Petrography and petrogenesis of Kimberlites and Carbonatite:s Anorthosites, Basalts, Ultramafites and Ophiolites, Monomineralic rocks, Alkaline rocks, Pegmatites, Lamprophyres, Granites

Module 4:

- Concept of Metamorphic zones. Concept of Metamorphic Grade, Concept of metamorphic facies series, Concept of metamorphic grade.
- Solid-solid reactions, Genetic significance of textures and structures of metamorphism. Application of thermodynamics in metamorphic rock formation. Paired metamorphic Belts and plate tectonics.
- Polymetamorphism, Retrograde metamorphism Metasomatism.Granitisation. Metamorphic reactions in carbonate rocks, basic rocks, argillaceous rocks and ultramafic rocks.

Module 5:

- Mineral paragenesis- Graphical representation of metamorphic mineral paragenesis, composition plotting ACF, AKF, AFM. Diagrams.

- Petrography and petrogenesis of Migmatites, Charnockites, Granulites, Marble, amphibolites, Schist, Gneiss, Slate and phyllite, Eclogite

Essential Reading:

1. Barth, T; F. W., Theoretical Petrology, Wiley, I Edn., Dover Publication, 1962
2. Bowen, N. D., Evolution of Igneous Rocks, I Edn., Dover Publication, 1956
3. Carmichael, Ian, S. E., Turner. F. J., Vcrhoogen, J., Igneous Petrology, McGraw Hill, 1971
4. Ehlers. E.G. The interpretation of Geological Phase Diagrams, Freeman, 1972
5. Hans Ramberg, The Origin of Metamorphic and Metasomatic Rocks, Chicago University Press. 1962
6. Hyndman, E. D , Petrology of Igneous and Metamorphic rocks, McGraw Hill,1972
7. Johansson, A Descriptive Petrography of Igneous rocks, Vol. 1,11, 111, IV, 1957
8. Johansson, Manual of Petrographic methods, McGraw Hill, 1952
9. Mason, B. D., Nelson, G. W., Lunar Rocks, Wiley, 1970
10. Miyashiro, A., Metamorphism and Metamorphic belts, Allan and Unwin, 1972
11. Phillips, Principles of Igneous and Metamorphic Petrology, Prentice Hall, 1990
12. Robert, F. Muller, and Surendra K. Saxena, Chemical Petrology, Springer Verlag,1977
13. Turner, F. J., Metamorphic Petrology, McGraw Hill, 1968
14. Tyrrel, G. W., Principles of Petrology, Methuen, 1963
15. Vernon R. H., Metamorphic Processes, Murby, 1976
16. Wahlstrom, E., Theoretical Igneous Petrology, Wiley, 1961
17. William, H., Turner, E. J., Gilbert, M. C, Petrology, Freeman, 1954
18. Winkler, H.C.F., Petrogenesis of Metamorphic rocks. III Edn,, Springer Verlag,1974.

GEL 4C 14 - ECONOMIC GEOLOGY

Credits: 4

Module 1:

- Significance of minerals in national economy. Tenor, grade and specification for minerals. India's status in mineral production. Strategic, critical an essential minerals. National mineral policy.
- Ore microscope polishing and mounting of ores. Physical and optical properties of important ore minerals

Module 2:

- Classification of ore deposits - Lindgren and Bateman classifications. Controls of ore localization, rnagmatic epochs and provinces. Micro textures of ore, Paragenesis and zoning. Geologic thermometry, wall rock alterations

Module 3:

- Ores in igneous rocks - ores of mafic and ultramafic associations - Ultra mafic-mafic chromium platinoid associations - form, distribution, setting, constitution and origin. Ores of felsic associations - the carbonatite associations - form, distribution, setting, constitution and origin. Anorthosite - Fe- Titanium oxide association, distribution, form, setting, constitution and origin.

Module 4:

- Strata bound and stratiform ore deposits - distribution, form, setting and origin. Ore deposits related to plate boundaries. Ore deposits of metamorphic affiliations.

Module 5:

- Coal Geology classification, petrography, genesis and periods of coal formation Distribution of coal fields of India, Neyveli Lignite Field.
- Petroleum Geology Introduction- physical properties and chemical composition, occurrence and origin. Source materials and source locations -conversion to petroleum. Reservoir rocks classification of reservoir traps - general, structural, stratigraphic, salt domes. Distribution of oil fields in India.
- A brief introduction to gas hydrates.

Essential Reading:

1. Anthony, M. Evans, An introduction to Ore Geology, Blackwell Scientific Publication, 1980
2. Ashok Mukherji, Ore Genesis - A Holistic approach, Prentice Hall, Calcutta
3. Bateman A. M., Economic Mineral Deposits, Wiley, 1962
4. Brian Mason, Principles of Geochemistry, Wiley, 1966

5. Brown, J. C, and Dey, A. K., India's Mineral Wealth, Oxford, 1936
6. Cameron, E. N., Ore Microscopy, Wiley, 1961
7. Edwards, A. B., Textures of the Ore Minerals, Aus. Inst. Min. and Met. 1960
8. Jenson and A. M. Bateman, Economic Mineral deposits, 111 Edn. John Wiley
9. Krauskopf, K., Introduction to Geochemistry, McGraw Hill, 1967
10. Levorson, A. I., Geology of Petroleum, McGraw Hill, 1958
11. Lindgren, Mineral Deposits, McGraw Hill, 1933
12. Nininger, R. D., Minerals for atomic energy, von Nostrand, 1956
13. Park C. G., and Mac Diarmid, R. A. Ore Deposits, Freeman, 1964
14. Rankama, K., and Sahama, T. G., Geochemistry, Chicago Uty. Press, 1949
15. Stanton, R. K., Ore Petrology, McGraw Hill, 1972
16. Tissot, B. P., and Welta, D. H., Petroleum formation and occurrence, Springer Verlag, 1978
17. Van Krcsalon, D.. Coal, Elsevier, 1961.

GEL 4C 15 - GEOCHEMISTRY AND SEDIMENTOLOGY

Credits: 4

Module 1:

- Origin and cosmic abundance of elements. Geochemical constitution of earth's crust, mantle, core and meteorites. Geochemical classification and distribution of elements. Primary differentiation of elements. Geochemical cycle.
- Elementary crystal chemistry and thermodynamics. Laws of thermodynamics Enthalpy.Fntropy,Heat capacty , Free energy , and Fugacity Gibbs phase rule and its applications to mineralogical systems. Eh-pH in sedimentary environments.

Module 2:

- Isotope geology . Application of isotopes: Stable isotopes -Carbon, Oxygen, Hydrogen and Sulphur
- Geochronology: Introduction to radioactivity, decay schemes, growth of daughter elements, fundamentals of dating methods. Experimental procedures and technical problems. Unstable isotopes- U-Th-Pb, K-Ar, Rb-Sr. Sm-Nd, C-14 and fission track methods in dating geological materials and events.
- Analytical techniques: Methods based on Flame photometer, Spectrophotometer, Atomic Absorption Spectrometer, Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-AES), Methods based on magnetic properties.

Module 3:

- Origin of sediments and sedimentary rocks: weathering, transportation, deposition, lithification and diagenesis. Elements of hydraulics. Provenance of sediments.
- Grain size classification, grade scale and sediment classes.Grain size analysis-sieving and pipette analysis, graphic representation of size analysis data; statistical parameters and their geological significance

Module 4:

- Textures of sedimentary rocks: clastic and non-clastic textures,Textural maturity. Structures of sedimentary rocks and their significance: primary and secondary structures.
- Classification of sedimentary rocks: Rudaceous, arenaceous argillaceous and calcareous rocks. Chemistry, Mineralogy and petrograph) of non-clastic Sediments: Siliceous, Phosphatic, carbonaceous and evaporate deposits

Module 5:

- Heavy minerals and their significance. Heavy mineral separation and identification; study of grain mounts. Mineralogical maturity.
- Depositional environments - Terrestrial, marine and transitional environments. Physico-chemical controls of sedimentation Tectonic control on sedimentation; Plate tectonics in relation to evolution of sedimentary basins. Sedimentary basins of India

Essential Reading:

1. Brian Mason, Principles of Geochemistry, Wiley 1966.
2. Brownlow, A.N., Geochemistry, Prentice Mall, 1975.
3. Gunter Faure, Principles of Isotope Geology, John Wiley and Sons, 1977
4. Konrad B. Krauskopf, Introduction to Geochemistry, McGraw Hill, 1979
5. Krauskof E.A. Introduction to Geochemistry, .McGraw Hill, 1967.
6. Paul Henderson, Inorganic Geochemistry, Pergamon Press 1982.
7. Rankama K,Progress in Isotopic Geology, Intcrscience , 1963.
8. Rankama,K and Sahama, T.H.C., Geochemistry. University of Chicago Press. 1950.
9. Blatt, R, Middleton, G., and Murray, R., Origin of Sedimentary Rocks, Prentice Hall, 1980
10. Carver, R. E. (Ed.), Procedures in Sedimentary Petrology, Interscience, 1971.
11. Collins and Thomson, Sedimentary Structures. George Allen & Unwin, London, 1982
12. Dickinson, W. R., and H. Yarborough, Plate tectonics and Hydrocarbon accumulation
13. Emery, K. O. and B. J. Skinner, Mineral deposits of the Deep Ocean Floor
14. Folk, R. I., Petrology of Sedimentary Rocks, Hemphill's University Station, Texas, 1968
15. Friedman, and Sanders, Principles of Sedimentology, John Wiley and sons, NewYork
16. Hatch and Rastall, Petrology of Sedimentary rocks, Thomas Murby & Co
17. Prothero and schwab, Sedimentary Geology, W.I 1. Freeman & Co.
18. Reineck and Singh, Depositional sedimentary environment Springer Verlag
19. Roy Thompson and Frank Oldfield, Environmental Magnetism, Allen and Unwin, London,1986
20. Pettijohn, I J.. Sedimentary Rocks, I larper and Row Pub. New Delhi, 1975
21. Peter, K. Weyl, Oceanography An introduction to the marine environment
22. Pettijohn, F. J., Potter, T. !•., Siever, R., Sand and Sandstone, Springer
23. Milner, Sedimentary Petrography, Vol. I and 11; George Allen and Unwin
24. Krumbein and Pettijohn, Manual of Sedimentary petrography.

CORE COURSE: PRACTICAL SYLLABUS

GEL 1C 04P - GEOMORPHOLOGY, STRUCTURAL GEOLOGY, APPLIED PALAEONTOLOGY

Credits: 4

Geomorphology:

- Interpretation of toposheets and identification of geomorphic features, fluvial and coastal land forms. Calculation of surface area and slope. Study of drainage pattern and morphometric analysis.

Structural Geology:

- Interpretation of geologic maps. Trigonometric, graphic and stereographic solutions to problems in structural geology. Geometric analysis of planar and linear structures. Fabric diagrams, Rose diagrams and histograms

Applied Palaeontology:

- Separation of microfossils and preparation of slides of Ostracoda, Foraminifera and Bryozoa. Identification and study of microfossils in slides, at least 10 Nos.

GEL 2C 08P - CRYSTALLOGRAPHY, MINERALOGY, HYDROGEOLOGY, AND APPLIED GEOLOGY

Credits: 4

Crystallography:

- Spherical projection of Cube, Octahedron and Dodecahedron.
- Stereographic projection of holohedral classes of all the systems, pyritohedral, tetrahedral, plagiohcdral classes of Isometric system and Rhombohedral classes of Hexagonal system.
- Gnomonic projections of the normal class of Isometric, Tetragonal, Hexagonal and Orthorhombic systems.
- Calculations of Axial ratios, Zone symbols, Napier's rule, Laws of anharmonic ratio.

Mineralogy:

- Identification of mineral specimens based on physical properties.
- Determination of the following optical characters by classical methods:
    - Order of interference colour
    - Sign of elongation
    - Birefringence
    - Scheme of pleochroism
    - Optic orientation
    - Determination of the vibration directions of polariser and analyzer
    - Extinction and extinction angle determination
    - Optic sign
    - Refractive index by Becke line method
- Identification of thin sections of important rock forming minerals
- Recalculation of mineral formula from EPMA analysis – Garnet; Pyroxene; Feldspar; biotite; hornblende

Hydrogeology:

- Preparation and interpretation of water table contour maps.
- Problems on Porosity, permeability, void ratio and Darcy's Law. Computation of aquifer parameters from pump test data.
- Graphical representation of hydro chemical data - Piper trilinear diagram, USSL Diagram, Stiffs polygon.
- Calculation of various parameters based on chemical data, electrical resistivity survey and interpretation of data.

Applied Geology:

- Engineering properties of rocks

GEL 3C 13P - EXPLORATION GEOLOGY, GEOPHYSICS, AND IGNEOUS AND METAMORPHIC PETROLOGY

Credits: 4

Exploration Geology:

- Problems in averaging assays. Estimation of ore reserves – Cut-off grade

Igneous and Metamorphic Petrology:

- Preparation of thin sections of igneous and metamorphic rock samples. (2 nos. each). Petrography of igneous and metamorphic rocks. Textures and structures of igneous and metamorphic rocks and their genetic significance with neat sketches. Determination of modal composition, Calculation of norm (25 exercises). Niggli values. Variation diagrams Harker, Larsen, Niggli. Calculation of Differentiation index. Peacock alkali-lime index. Use of triangular diagram in the classification of igneous rocks. Use of triangular diagram in the classification of igneous rocks. Identification of metamorphic mineral paragenesis in hand specimens and thin sections and arranging them according to the intensity of metamorphism. Graphical representation of metamorphic mineral parageneses. ACF and AKF diagrams. AFM diagrams. Construction of phase diagrams based on experimental data of the following systems- Albite-anorthite, Forsterite-fayalite, Diopside- anorthite, Diopside - albite, Forsterite -silica.

GEL 4C 16P - ECONOMIC GEOLOGY, GEOCHEMISTRY, AND SEDIMENTOLOGY

Credits: 4

Economic Geology:

- Identification of important ore minerals. Collection and display of data on production, consumption and export of important minerals. Identification of ore minerals under ore microscope. Genetic significance of important ore.

Geochemistry:

- Calculation of isotope proportions in samples.
- Determination of pH of groundwater samples
- Determination of Na and K using flame photometer
- Calculation of bulk rock compositions from modal mineralogy and mineral chemistry
- Calculation of $\delta^{18}O$ in water reservoirs and ice-cores
- Calculation of palaeo sea-surface temperatures
- Calculation of age of rock samples based on different decay schemes

Sedimentology:

- Sieve analysis - plotting of sieve analysis data - histogram, Folk and Ward, Trask methods.
- Measurement and calculation of shape parameters, plotting and interpretation of these data Separation of light and heavy minerals.
- Preparation of grain mounts. Study of grain mounts of Magnetite, Ilmenite, Monazite, Rutile, Garnet, Sillimanite, Zircon, Quartz, Leucoxene and Hornblende.
- Microscopic and megascopic study of sedimentary rocks.

ELECTIVE COURSE: THEORY SYLLABUS

GEL 3E 01 - REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

Credits: 4

Module 1:

- Brief History and the developments in Aerial photography. Geometry and type of aerial photographs. Scale of photographs. Type of aerial cameras, films and filters. Multiband photography. Tilt and height displacement. Vertical exaggeration.
- Stereoscopy. Mosaics. Elements of photo interpretation: tone, texture, pattern, drainage and lineaments. Use of Aerial photographs in photogrammetry, land use, forestry, agriculture, environmental studies.

Module 2:

- Principles of Satellite Remote Sensing. Electromagnetic spectrum. Platforms and sensors. Space-borne platforms. Sun synchronous and geosynchronous satellites. Description of payloads.
- Land coverage capability- detector arrays- sensitivity. Resolution concepts – Spatial, Spectral, Radiometric and Temporal resolutions; Multi Spectral Scanners (MSS). Spectral signatures x

Module 3:

- Principles and applications of thermal detectors. Thermal Infrared scanners- airborne and space borne TIR sensors. Airborne and satellite borne RADAR. SLAR.
- Application of remote sensing data in i) geomorphologic mapping, ii)Fluvial, coastal, deltaic landforms, iii) lineaments iv) lithology v) ground water exploration, vi) land use / land cover mapping. Status of remote sensing studies in India

Module 4:

- Fundamentals of GIS. Components of GIS. Digitization of information and encoding. Vector and Raster formats Elements of topology. Concept of Thematic maps. Map Registration, topology creation, transformation, and projection

Module 5:

- Creating Maps using any one of the GIS software – Arc View / ArcGIS / Map Info. Application of GIS in various disciplines Geology, Urban Planning, Forestry, Hydrology, and Agriculture

Essential Reading:

1. Avery, T.E. Interpretation of aerial photographs, Burges Publishing Co 1968
2. Burrow, P. A. and Mc Donnel, R. A. Principles of Geographic Information Systems, Oxford Publishers, 1998
3. Clark, K.C. Getting started with Geographic Information System, Prentice Hall,1990
4. Demer, M.N. Fundamentals of GIS, John Wiley & Sons, 2000.
5. Dickinson, A. E. Maps and Air photographs, Edward Arnold, 1979

6. Drury, S. A. Image interpretation in Geology; Chapman and Hall, London, 1993
7. ESRI. Understanding Geographic Information System. The Arc lnfo Method, Wiley Publishers
8. Estes, J.W. and Leslie W. Senger, Remote Sensing - Techniques for Environmental analysis, Hamilton Publishing Co., 1974
9. Heywood, 1. Cornelius, S. and Canver, S. An introduction to Geographical
10. Information System, Pearson Education Asia Pvt. Ltd. 1993
11. Jensen, J. R. Remote sensing of the environment - An Earth Resource Perspective, Cambridge University Press, 2000
12. Matter, P.M. Computer processing of remotely sensed images, second edition,Wiley Eastern, 1999
13. Peter A. Burrough and Ruchael, A. McDonnell, Principles of Geographical Information System, Oxford Publishers
14. Siegal, D.S., Gillespie A.R. Remote Sensing in geology, John Wiley, 1980
15. Star, J. Ester, J. Geographic Information System - An introduction, Prentice Hall,
16. 1990
17. Thomas M. Lilesand, and Ralph W. Keiferr. Remote Sensing and Image Interpretation, John Wiley and Sons 1979.

GEL 3E 02 - CLIMATOLOGY

Credits: 4 **Total Hours: xx**

Module 1:

- Structure and composition of the atmosphere – Global warming

Module 2:

- Climatic zones and types- main climatic zones, classification- Climatic groups and their subdivisions. Geographical distribution of the climatic types – Koppen's and Thornthwaite's classification of climate

Module 3:

- Cloud formation and precipitation processes – Air sea interaction on different space and time scales. Insolation and heat budget. Radiation balance. General circulation of the atmosphere and ocean

Module 4:

- Climate and sea level changes on different time space. Coupled ocean atmosphere system. EL Nino southern oscillation (ENSO), LaNino

Module 5:

- General weather systems of India, Monsoon system, Cyclone and anticyclone, Jet stream. Distribution of precipitation over India. Western disturbances and severe local convective systems

Essential Reading:

1. Berneard Hauruitz and James, M. Austin, Climatology, Mc Graw Hill publications, Newyork & London.
2. D.S. Lal., Climatology
3. Austin Miller. A., Climatology
4. B.S. Negi., Climatology and oceanography.

GEL 3E 03 - SEISMOLOGY

Credits: 4

Module 1:

- Introduction to seismology; seismic sources; earthquake distributions
- Elastic deformation and stress tensors and their relationships; Helmoltz's theorem;
- Wave surfaces, rays and their properties; velocities and motions associated with body waves; refraction and reflection of elastic waves at solid-solid and liquid-liquid interfaces.

Module 2:

- Seismometry: electromagnet instruments and global networks; force-feedback instruments and digital global networks; seismic arrays and regional networks.

Module 3:

- Seismogram interpretation: Nomenclature; travel time curves, locating earthquake by single and multi-station and inverse methods.

Module 4:

- Seismology and earth's structure: seismic tomography of earth; active-source imaging techniques- earth's crust; passive imaging techniques- structure of the mantle and core; Joint hypocenter determination

Module 4:

- Seismotectonics: focal mechanism and fault-plane solutions; seismicity along divergent, transcurrent and convergent boundaries, intraplate earthquakes.
- The earthquake cycle; Earthquake prediction

Essential Reading:

1. Aki, K. and Richards, P.G., 1980. Quantitative Seismology: Theory and Methods, San Francisco: W. H. Freeman.
2. Bullen, K. E. and Bolt, B.A. (1985). An Introduction to the Theory of Seismology, Cambridge: Cambridge University Press.
3. Lee, W.H. International Handbook of Earthquake and Engineering Seismology, Academic Press
4. Lowrie, W., 2011. A Student's Guide to Geophysical Equations. Cambridge University Press.
5. Shearer, P.M., 2009. Introduction to Seismology. Cambridge University Press.
6. Stein, S. and Wysesson, M., 2002. An Introduction to Seismology, Earthquakes and Earth Structure, Blackwell.

GEL 4E 04 - ENVIRONMENTAL GEOLOGY

Credits: 4

Module 1:

- The physical environment of earth. Natural resources: conservation and preservation. Concept of sustainable development. Geologists' role in environmental management and planning. Interaction between human and Nature.
- Disaster management. Environment impact Assessment (EIA), Environmental mapping.

Module 2:

- Geological processes and hazards created by human. Environmental consequences of natural hazards like earthquakes. Landslides arid volcanic activity. Conservation and land use planning.
- Urban development. Soil conservation. Wastes created by human activity such as mining and industrial activities
- Pollution studies and its significance. Air and Water pollution

Module 3:

- Water pollution: Sources, problems originating above the land surface. Disposal of wastes, dumps, sewages, problems originating above the water table - waste disposal, agricultural drainage, subsurface storage, mines, nuclear implosion.

Module 4:

- Controls of ground water pollution - collection and treatment, detoxification and biodegradation, health hazards due to ground water pollution-heavy metals, radioactive material. Microbes, BOD and COD

Module 5:

- Coastal environments: -Distribution, variation and interaction of Physico - chemical and geological parameters on near shore and free shore ecosystems. Mangroves Marine pollution; Causative factors- land based sources- marine based sources- types of pollution- oil spills- processes of oil water interface- effects on ecosystems

Essential Reading:

1. Donald R Coates Ed. Environmental Geomorphology & Environmental Geoscience.Wiley International
2. Donald R Coates, 1981. Environmental Geology. John Wiley and sons
3. Eennis Barlin 1980 Earthquakes and Urban Environment V.1,2&3 CRC Press
4. Peter T Elavan, l970. Environmental Geology, Harper& Row

GEL 4E 05 - DISASTER MANAGEMENT

Credits: 4

Module 1:

- Introduction- Hazard and Disaster: Definition and Terminologies, Classification. Understanding Disaster Management: Comprehensive Disaster Management Plan and it's Elements, Disaster Management Act-2005, and its Institutional Framework- Policy and Administrative frame work for Disaster Management

Module 2:

- Understanding Natural Disasters: Earth Quake, Landslides, Avalanches, Volcanic eruptions. Heat and Cold waves, Coastal Disasters, Cyclone, Flood, Drought ,Tsunami

Module 3:

- Understanding Man-made Disasters: Nuclear Disasters, Chemical Disasters, Biological Disasters, Building fire, Coal fire, Forest fire and Oil fire, Rail accident, Road accidents, Air accidents, Sea accidents, Dams and Dam bursts, Air pollution, Water pollution, Industrial pollution, Climate change: Global warming, sea level rise, Ozone Depletion

Module 4:

- Hazard, Risk and Vulnerability: Concept and Elements, Risk Reduction Disaster Management.: Prevention, Preparedness and Mitigation.. Disaster Preparedness Plan, Role of Information, Education, Communication and Training, Role of various Agencies in Disaster Response, NGO's, Armed Forces, Police and other Forces

Module 5:

- Potential hazards in Kerala with special reference to landslides and coastal erosion during the monsoons. Manmade drought during summer, saline water intrusion along the coastal aquifers – mitigation measures
- Cyclone, drought and flood in various parts of India – frequency of occurrence, vulnerable areas- reasons

Essential Reading:

1. Abbot.P.C (2002): Natural Disaster, McGraw Hill Publications New Delhi
2. Coates.D.R (1985) Geology & Society – Chapman & Hall Publishers New Delhi
3. Davis et.al (1976) Environmental Geosciences – Wiley Eastern
4. Howard A.D & Irwin Remson (1978) – Geology in Environmental Planning –McGraw Hill Publishers
5. Keller E.A (1976) – Environmental Geology – Charles E Merril publishers – New Jersey
6. Lundgren.L(1986) Environmental Geology – Prentice Hall Publication- New Jersey
7. Strahler N & Strahler A.H (1973) – Environmental Geosciences Wiley eastern publishers

GEL 4E 06 - GEOTECHNICAL ENGINEERING

Credits: 4

Module 1:

- Soil structure; types of bonds; important clay minerals; base exchange capacity.
- Clay-water interaction; Lambe's compaction theory; field compaction method
- Structural and engineering properties of compacted soil.

Module 2:

- Type of soil samples – Disturbed samples; undisturbed samples; design features affecting the sample disturbance; split spoon samplers – scraper bucket samplers – piston samplers.
- Engineering classification of rock mass; defects in rocks; physical mechanical properties of rocks.

Module 3:

- Laboratory tests for shear strength; tensile strength; flexural strength; elastic constant.
- Field tests – standard penetration test; core penetration test; in-situ Vane shear test – plate load test – monotonic and cyclic-field permeability tests.

Module 4:

- Slope stability – role of discontinuities in slope failures; slope analysis and safety factor – remedial measures for critical slopes.
- Earthquake resistant design of foundation of buildings; seismic analysis; earthquake response of slopes- pseudostatic analysis

Module 5:

- Ground improvements: scope and necessity of ground improvements in geotechnical engineering; drainage – groundwater lowering by well points deep wells, vacuum and electro-osmotic methods; stabilization by thermal freezing techniques.
- Earth reinforcement – principles and basic mechanisms; synthetic and natural fibre based Geotextiles and their applications; measures on erosion control.

Essential Reading:

1. Herget, G., Stresses in Rocks. Balkema, Rotterdam, The Netherlands.
2. Goodman, R.E., Introduction to Rock Mechanics. John Wiley and Sons.