File Ref.No.72046/GA - IV - J3/2019/Admn

UNIVERSITY OF CALICUT

Abstract

General & Academic - CCSS PG Regulations 2019 - M.Sc Applied Geology Programme w.e.f 2020 Admission - Scheme and Syllabus incorporating Open elective course Disaster Management - Implemented - Subject to ratification by the Academic Council - Orders Issued.

G & A - IV - J

U.O.No. 1229/2022/Admn Dated, Calicut University.P.O, 17.01.2022

Read:-1. U.O.No. 5496/2021/Admn dated 23.05.2021
2. U.O.No. 12778/2021/Admn dated 22.10.2021
3. E-mail from the Chairperson, Board of Studies, Geology, dated 09.12.2021
4. Remarks of the Dean, Faculty of Science, dated 15.12.2021
5. Orders of the Vice Chancellor in the file even no., dated 15.01.2022

ORDER

1. Scheme & syllabus of M.Sc Applied Geology Programme under CCSS PG Regulations 2019 in the teaching dept. of the University, incorporating Outcome Based Education (OBE) in the existing syllabus, w.e.f 2020 admn. was implemented, vide paper read (1) above.
2. The syllabus of open elective course- Disaster Management to be offered by the Dept. of Geology in III semester for other teaching depts. was implemented, vide paper read (2) above.
3. The Chairperson, Board of Studies in Geology forwarded the draft scheme and syllabus of M.Sc Applied Geology Programme under CCSS PG Regulations 2019 in the the Teaching Department of the University w.e.f 2020 admission, incorporating the Open elective course-Disaster Management, including the course code, approved by the Board of Studies by circulation as per Chapter 3(34) of Calicut University First Statute, 1976.
4. The scheme & syllabus of M.Sc Applied Geology Programme (CCSS-PG-2019), incorporating Open elective course-Disaster Management, including the course code, in tune with the CCSS PG 2019 regulations under the teaching dept. of the University, wef 2020 admn. has been approved by the Dean, Faculty of Science, vide paper read (4) above and by the Vice Chancellor, subject to ratification by the Academic Council, vide paper read (5) above.
5. Scheme and syllabus of M.Sc Applied Geology (CCSS), incorporating Open elective course-Disaster Management including the course code, in accordance with CCSS PG Regulations 2019, is therefore implemented with effect from 2020 admission in the Teaching Department of the University, subject to ratification by the Academic Council.
6. U.O. read (1) above, is modified to this extent.
7. Orders are issued accordingly. (Updated syllabus appended)

Arsad M

Assistant Registrar

To

The Co-ordinator, Department of Geology
Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/DR, SDE/JCE I/JCE V/DoA/EX and EG Sections/GA I F/CHMK Library/Information Centres/SF/DF/FC

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

(2020Admission onwards)

Under

Choice Based Credit Semester System – CCSS

UNIVERSITY OF CALICUT

Board of Studies in Geology (UG&PG Combined)
University of Calicut
June 2019

University of Calicut

Scheme of PG Programme under CCSS PG in Applied Geology

Rules, Regulations, and Syllabus

1. TITLE

The existing regulations of Choice-based Credit Semester System (U.O.No.4500/2019/Admn Dated 26-03-2019), which are applicable for University Teaching Departments are applicable for this Programme.

2. 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 50% marks (or equivalent grades) are eligible for appearing the entrance examination to this programme.

3.ADMISSION

Entrance examination will be conducted by the University of Calicut. Admission is Based on the entrance marks only.

4.DURATION OF THE PROGRAMME

1) The minimum duration for successful completion of M.Sc. (Applied Geology) programme shall be 2 years, split into 4 semesters. The maximum period for completion is 4 years.
2) The duration of each semester shall be 90 working days, inclusive of examinations, spread over five months.
3) Odd semesters shall be held from June to October and even semesters from November to March subjected to the academic calendar of the University.

5.PROGRAMME STRUCTURE AND SCHEME OF EXAMINATIONS

1) The programme shall include three types of courses: Core courses, Elective courses and Audit Courses.
2) Comprehensive Field work/Study Tour, Mapping Camp, Viva-voce, and Project Work / Dissertation shall be treated as Core Courses.
3) Total credit for the programme shall be 80 (eighty), this describes the marks of the course concerned and the pattern of distribution as detailed below. A student shall accumulate a minimum of 80 credits for the successful completion of the programme.

4) There shall be University examination for theory courses at the end of each semester, to be conducted after the completion of 90 working days . Each theory course examination will be of 3 hour duration.

5) 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.

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

7) Evaluation of the report of field work shall be conducted along with the second semester practical examination. Evaluation of Combined Field Mapping and Project / dissertation and viva-voce shall be conducted at the end of the programme only.

a. Study Tour/Field Work and Combined Field Mapping Camp.

Extensive field work with emphasis on Stratigraphy, Structural Geology, Economic Geology, Palaeontology, and Petrology extending for two-to three-weeks in different parts of India are integral and mandatory component of the program. The study tour should be organized in such a way that a major portion of the entire tour period is exclusively allocated for field-based studies, including visit to quarries, mines and locations of geological interest, and limited time slots may be reserved to visit Academic/Research institutions.This may be carried out as one stretch or two-stretches within the first two semesters of the programme.

Mapping camp, extending for two-to three-weeks in a particular location, anywhere in India with emphasis on structural and lithological mapping shall be carried out during third or fourth semester of the programme.

b. Audit courses

In addition to the above courses there will be two Audit Courses (Ability Enhancement Course & Professional Competency Course) with 4 credits each. These have to be done one each in the second and third semesters. The credits will not be counted for evaluating the overall SGPA & CGPA. The University Teaching Departments shall conduct examination for these courses and have to intimate /upload the results of the same to the University on the stipulated date during the fourth Semester. Students have to obtain only minimum pass requirements in the Audit Courses. The details of Audit courses are given below:

Course Outcomes:

- *The student will be able to skilled in different technical aspects of Geology such as Thin section making, Geophysical Resistivity Survey and Various Geological Survey.*
- *The student will be able to skilled in different softwares such as Arc GIS/ QGIS/ERDAS/ENVI etc.*

Semester	Course Title	Suggested Area	Details
II	Ability Enhancement Course (AEC)	Internship/Seminar presentation/ Publications/Case study analysis/Industrial or Practical Training/research methodology/ Community linkage programme etc.	Theory examinations/Practical Examinations/Viva Voce for concerned subject of 100 marks
III	Professional Competency Course (PCC)	To test the skill level of students like testing the application level of different software such as Arc GIS /QGIS/ERDAS/ENVI/GtAide/WATCHIT etc.	Theory examinations/Practical Examinations/Viva Voce for concerned subject of 100 marks

Note**: A)For Ability Enhancement Course (AEC) :** Students can take trainings in Geology or interdisciplinary subjects from various institutions all over India.

OR

Students can take any one of the trainings provided from the Geology Department, University of Calicut in following Streams :

1)Training on Thin section making :Rock/Mineral cutting,Grinding,Polishing and making of a perfect thin section.

2)Training on Geophysical Resistivity Survey : Geophysical Resistivity Survey for Ground water well site identification/mineral prospecting , identification of over burden thickness and find out hard rock type.

3)Various Geological Survey: Hydrogeological Survey/Geostatistical Survey/Total Station Survey/Mineralogical Survey/GPR survey/Meteorological Survey/Coastal Survey etc..

B)For Professional Competency Course (PCC) : Testing the application level of software such as Arc GIS/QGIS/ERDAS/ENVI etc..

1)Skill Test includes: Georeferencing the given scanned image, digitization of different attributes such as road,river,forest cover etc. Preparation of Maps.Creation of Clip & Mosaic.Image classifications and application of GPS.Land use/Land cover change detection etc.

Components of Evaluation of Audit courses

Sl. No.	Component	Marks
i)	Training Report/Training record	20
ii)	Practical Test /Viva	50
iii)	Field work/involvement	15
iv)	Skill/Ability of work	15
	Total	**100**

6.Credits and marks for proposed various papers, and evaluation scheme

Semester	Course Type	Course Code	Course Title	Credits	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	Remote Sensing & Geographic Information System	4	20	80	100
	Theory	GEL 1C 04	Stratigraphy & Applied Palaeontology	4	20	80	100
	Practical*	GEL 1L 01	Geomorphology, Structural Geology, Applied Palaeontology & Geographic Information System	3	20	80	100
II	Theory	GEL 2C 05	Advanced Mineralogy	4	20	80	100
	Theory	GEL 2C 06	Hydrogeology	4	20	80	100
	Elective#	GEL 2E 01a	Mining Geology & Engineering Geology	4	20	80	100
		GEL 2E 01b	Seismology				
	Elective#	GEL 2E 02a	Marine Geology	4	20	80	100
		GEL 2E 02b	Coal & Petroleum Geology				
	Practical*	GEL 2L 02	Mineralogy and Hydrogeology	3	20	80	100
	Field Work‡	GEL 2F 01	Study Tour	3	20	80	100
	Viva-Voce	GEL 2V 01	Viva-Voce	1	10	40	50
III	Theory	GEL 3C 07	Igneous & Metamorphic Petrology	4	20	80	100
	Theory	GEL 3C 08	Exploration Geology & Applied Geophysics	4	20	80	100
	Elective#	GEL 3E 03a	Environmental Geology	4	20	80	100
		GEL 3E 03b	Quaternary Geology				
	Elective#	GEL 3E 04a	Climatology & Disaster Management	4	20	80	100
		GEL 3E 04b	Geotechnical Engineering				
	Practical*	GEL 3L 03	Igneous and Metamorphic Petrology, Exploration Geology & Applied Geophysics	3	20	80	100
IV	Theory	GEL 4C 09	Geochemistry and Sedimentology	4	20	80	100
	Theory	GEL 4C 10	Economic Geology	4	20	80	100
	Practical*	GEL 4L 04	Geochemistry, Sedimentology & Economic Geology	3	20	80	100
	Dissertation±	GEL 4P 01	Project/Dissertation	4	20	80	100
	Field Mapping†	GEL 4M 01	Combined Field Mapping	3	20	80	100
	Viva-Voce	GEL 4V 02	Viva-Voce	1	10	40	50
Total for the programme				**80**	**440**	**1760**	**2200**

*Practical exams will be held at the end of even semesters.

‡Evaluation shall be conducted along with second semester practical examination.

#In an academic year, the department may offer any one among these courses.

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

†Evaluation of the mapping programme shall be held at 4th semester of the programme.

Syllabus of GEL 3E 03c DISASTER MANAGEMENT , open course elective for other departments are given on page 52

7. 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.

7.1. 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 details of marks assigned to various components for internal evaluation are as follows:

7.1.1.Components of Internal Evaluation / Continuous Assessment

7.1.1.1.Theory

Sl. No.	Component	Marks
i)	Examination/Test	8
ii)	Seminars/Presentation	5
iii)	Assignment	4
iv)	Attendance*	3
	Total	**20**

*90% and above = 3 marks; 80 to 89% = 2 marks; 75 to 79 = 1 mark; below 75 % = Nil

7.1.1.2.Practical

Sl. No.	Component	Marks
i)	Lab skill/Quality of Record	5
ii)	Practical Test	10
iii)	Viva	5
	Total	**20**

7.1.1.3.Study tour

Sl. No.	Criteria	Marks
1.	Field work/involvement	6
2.	Specimen collection/ preparation of geological sketches and maps	4
3.	Study Tour Report	6
4.	Viva-Voce	4
	Total	**20**

7.1.1.4. Combined field mapping

Sl. No.	Criteria	Marks
1.	Field work/involvement	6
2.	Specimen collection/preparation of maps	4
3.	Report	6
4.	Viva-Voce	4
	Total	**20**

7.1.1.5.Dissertation

Sl. No.	Criteria	Marks
1.	Punctuality	4
2.	Use of Data	4
3.	Scheme/Organization of the Report	6
4.	Viva-Voce	6
	Total	**20**

The marks for viva-voce can be given based on the subject knowledge and subject aptitude of the Candidate.

7.2. 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:

7.3.Pattern of Questions for External Evaluation

Each theory question paper may contain 8 short notes types of questions out of 8, of marks 2; 6 short essays out of 10 of marks 6; and 2 long essays out of 4, with marks of 14 each.

Sl. No.	Type of Questions	Individual marks	Total marks	Number of questions to be answered
1	Short notes type questions	2	2 X 8 = 16	8 out of 8
2	Short essays	6	6 X 6 = 36	6 out of 10
3	Long Essay type questions	14	14 X 2=28	2 out of 4

7.4.Attendance

The students admitted in the PG programmes shall be required to attend at least 75 percent of the total number of classes (theory as well as practical) held during each semester. The students having less than prescribed percentage of attendance shall not be allowed to appear for the University examination.

Condonation of shortage of attendance for a maximum of 9 days (10% of the working days in a semester) in the case of single condonation and 18 days (20% of the working days in a semester) in the case of double condonation in a semester subject to a maximum of two times (for single condonation only) during the whole period of Post Graduate programme may be granted by the University as per the existing procedures. In the case of double condonation, only one condonation shall be allowed during the entire programme.

7.5. Minimum requirements for the successful completion of the programme

Pass Minimum for External Examinations = 40%

No pass minimum for Internal Examinations.

Pass Minimum for a Course = P 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: GEOLOGY

(THEORY)

PROGRAMME OUTCOMES

PO1. Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2. Problem Solving: Understand and solve problems of relevance to society to meet the specified needs using the knowledge, skills and attitudes acquired from humanities/ sciences/mathematics/social sciences.

PO3. Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO4. Effective Citizenship: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO5. Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

PO6. Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

PROGRAMME SPECIFIC OUTCOMES

PSO1. Apply the concepts of Physical geology, Geomorphology, and Historical Geology.in solving problems and taking decisions.

PSO2. Understand the physical, chemical and optical characteristics of rocks and minerals, their economic aspects and distribution so as to suggest and promote the wise use of the resources.

PSO3. Understand the structural aspects of rock formations, global tectonics and earth dynamics in order to help the society in understanding and managing natural disasters, wherever possible.

PSO4. Discuss the applications of geoscience in environmental planning and management.

GEL 1C 01 - PHYSICAL GEOLOGY AND GEOMORPHOLOGY

Credits: 4

Course Outcomes:

- *The student will be able to discuss and explain about the origin and evolution of earth, earth's various layers and their properties.*
- *The student will be able to demonstrate the role of various geological agents and illustrate the landscape evolution.*
- *The student will be able to explain the geological significance, classification and mode of formation of wetlands.*
- *The student will be able to describe the geomorphology of Kerala and India.*
- *The student will be able to apply the principles of geomorphology in Civil Engineering, Hydrogeology, and Environmental Studies.*

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.
- Thermal history of the Earth - Geothermal gradient. Heat budget of the earth, 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.
- Glaciers: types of glaciers and movement. Crevasses, erosional features. Glacial and fluvoglacial deposits.
- Desert Geomorphology – Processes of erosion and transport – erosional and depositional features – dunes, rock varnish, pediment, inselbergs, wadis.

Module 4:

- Wetlands- Geological significance, classification and mode of formation. The Indian scenario - conservation and management in India. Backwaters (Kayals) of Kerala. Soils - formation, 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.
- Applied Geomorphology: Application of Geomorphology in Civil Engineering, Hydrogeology, and Environmental Studies.

Essential Reading:

1. Ahamed, E., 1972. *Coastal Geomorphology of India*. Orient Longman, New Delhi.
2. Cox. A. Plate tectonics and geomagnetic reversals, Freeman, 1973
3. Eicher.L.D., Geologic Time, Prentice Hall, 1968
4. Hamilton, E. I., Applied geochronology, Academic Press, 1965
5. Holmes, A. Principles of Physical Geology, Ronald, London, 1972
6. King, C.A.M. Beaches and Coasts, Arnold, London, 1972
7. Leopold, L. Wolmen, C. and Miller J.P. Fluvial processes in Geomorphology, EPH Publishing House, New Delhi, 1976
8. Pethick, J., An introduction to coastal geomorphology, Arnold Heinman publishers, (India), New Delhi, 1984
9. Schumm, S .A. (Ed), Drainage Basin morphology- In Bench mark papers in Geology
10. Shartna, H. S.s Indian geomorphology, Concept Publishing .Co, New Delhi, 1990
11. Thornbury, W.D. Principles of Geomorphology, Wiley, 1968
12. Windley, B.F., The evolving continents, John Wiley,& Sons
13. Savindra Singh, Geomorphology, Pravalika publications, Allahabad

GEL 1C 02 - STRUCTURAL GEOLOGY AND GEOTECTONICS

Credits: 4

Course Outcomes

- *The student will be able to demonstrate the geological mapping skills in any terrain.*
- *The student will be able to illustrate the stress and strain concepts with the help of graphical representations.*
- *The student will be able to explain the relationship between various structural features and the processes responsible for their formation.*
- *The student will be able to illustrate the various tectonites and shear sense indicators.*
- *The student will be able to describe tectonic evolution of Earth's continental crust.*
- *The student will be able to explain the plate tectonic system in earth, plate kinematics, and geodynamic evolution of Indian plate.*

Module 1:

- Geological mapping and map reading; Attitudes of planes and lines and their representation.
- Brittle and ductile deformation; Behaviour of minerals and rocks under deformation conditions; Rheology.
- Concept of stress and strain; Relationships for elastic, plastic and viscous materials; Strain and displacement; Graphical representation of finite strain: Strain ellipsoid; Flinn diagram and Mohr Circle.
- Folds: Mechanics of folding; Geometric classification after Ramsay; Genetic classification after Donath and Parker; Minor folds and their uses in determining the major fold structure; Pumpelley's rule. Superposed folding and interference patterns.

Module 2:

- Joints and fractures: Distinction; Joint formation in response to loading and stress; Fracture development and propagation; Classification of joints and extension fractures.
- Faults: Dynamics of faulting; Displacement, slip and separation; Fault geometry and classification; Characteristics of faults and fault zones. Crustal scale faults: Strike-slip, transpression, and transtension.

Module 3:

- Tectonites: Fabric elements and classification; S-C fabric; Petrofabric analysis.
- Shear Zones: Brittle and ductile shear zones, geometry and products of shear zones; shear sense indicators; Mylonites and cataclasites, their origin and significance.
- Stereographic projections: linear and planar features.

Module 4:

- Major tectonic features of the earth: Birth and growth of Ocean basins and Continental crust.
- Plate tectonic system in Earth: Lithosphere-Asthenosphere system; Driving mechanism; Mantle convection; Heat transfer and tectonics.
- Plate Tectonics - Concept of plate tectonics. Types of plate boundaries. Characteristic features of accretionary, conservative and destructive boundaries.

Module 5:

- Mid-Ocean ridges: Composition and Structure; Magnetic anomaly stripes, Palaeomagnetism and its application for determining palaeoposition of continents.
- Seismic belts of the earth. Geodynamic evolution of the Indian plate - Evolution of Himalaya and Himalayan tectonics.

Essential Reading:

1. Artemieva, I.M., 2011. *The Lithosphere- An Interdisciplinary Approach*. Cambridge University Press, 773 p.
2. Condie, K.C., 2011. *Earth as an Evolving Planetary System,* Academic Press, Oxford, UK, 574p.
3. Davis, G.H., Reynolds, S.J., Kluth, C.F., 2012. *Structural Geology of Rocks and Regions.* 3rd Edition, John Wiley & Sons, Inc. 839 p.
4. Fossen, H., 2010. *Structural Geology.* Cambridge University Press, 463 p.
5. Frisch, W., Meschede, M., and Blakey, R., 2011. *Plate Tectonics: Continental Drift and Mountain Building,* Springer-Verlag, Berlin Heidelberg, 212p.
6. Ghosh, S.K., 1993. *Structural Geology: Fundamentals and Modern Concepts.* Pergamon Press, Inc., 598 p.
7. Marshak, S., Mitra, G., 2018. *Basic Methods of Structural Geology.* Pearson Educations, 446 p.
8. Moores, E.M., Twiss, R.J., 2014. *Tectonics.* W.H. Freeman, 672 p.
9. Passchier, C.W., Trouw, R.A.J., 2005. *Microtectonics.* Springer-Verlag, 366 p.
10. Stüwe, K., 2007. *Geodynamics of the Lithosphere*. Springer-Verlag, 493 p.
11. Turcotte, D.L. and Schubert, G., 2014. *Geodynamics,* 3rd Edition, Cambridge University Press, 636 p.
12. Van der Pluijm, B.A., Marshak, S., 2004. *Earth Structure: An Introduction to Structural Geology and Tectonics.* W.W. Norton & Company, Inc., 656 p.

GEL 1C 03 – REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

Credits: 4

Course Outcomes

- *The student will be able to explain the fundamentals of aerial photography and remote sensing.*
- *The student will be able to discuss electromagnetic spectrum, resolution concepts, various sensors, and Indian remote sensing satellite missions.*
- *The student will be able to explain the fundamentals of digital image processing and classification, thermal and microwave remote sensing.*
- *The student will be able to apply the remote sensing techniques in mineral exploration, ground water exploration, land use/land cover mapping and geomorphology.*
- *The student should be able to explain the working principles of Geogrpahic Information System.*
- *The student should be able to explain the GIS Applications in urban planning, groundwater studies, mineral exploration, disaster management, climate change analysis.*

Module 1:

- Brief history and development of remote sensing. Geometry and type of aerial photographs. Scale of photographs.
- Tilt and height displacement. Vertical exaggeration. Stereoscopy. Mosaics.
- Elements of photo interpretation: tone, texture, pattern, drainage, lineaments, Shape, and Association. Photogrammetric Instruments.

Module 2:

- Electromagnetic spectrum
- Principles of Satellite Remote Sensing. Platforms and sensors.
- Resolution concepts- Spatial, Spectral, Radiometric and Temporal resolution. Multi Spectral Scanners (MSS).
- Camera for remote sensing, films for remote sensing, Optical mechanical scanner, Push broom scanner, Imaging spectrometer, Atmospheric sensor, Sonar, Laser radar. Spectral signatures.
- Indian remote sensing satellite missions.

Module 3:

- **F**undamentals of digital image processing and classification: Flow of Digital Image Processing, Radiometric Correction, Geometric Correction, Image Enhancement, Spatial Filtering, Feature Extraction, Classification Methods. FCC.
- Image classification and accuracy assessment - supervised & unsupervised classification

Module 4:

- Thermal remote sensing-Principles and applications of thermal detectors, Thermal Infra-Red scanners- airborne and space borne TIR sensors.
- Optical Remote Sensing- Panchromatic, Multispectral, Hyperspectral, Superspectral.
- Microwave Remote Sensing- Introduction, attenuation of microwave, microwave radiation, surface scattering, volume scattering, types of antenna, RADAR
- Application of remote sensing in mineral exploration, ground water exploration, land use /land cover mapping and geomorphology.

Module 5:

- History of GIS-Definition of GIS, Components of GIS-Hardware, Software, Brainware, Infrastructure.
- Map: Overview, Geographic data-Spatial and Non spatial data, Elements of a map-Scale, Datum, Coordinate system, Projection. Types of coordinate system, Map projection-Types of Map Projection (Azhimuthal, Conial, Cylindrical). Types of Map-Topographical map, Large scale map, Thematic map. Vector and Raster formats.
- Data sources. Software and technology. Desktop GIS. Five fundamental functionalities of a desktop GIS: data input and output, visualization, editing, analysis, and map design. Web mapping. Clients and servers. Mobile GIS.

Module 6:

- Data model: Spatial data model-Raster data model and vector data model, Advantage and Disadvantages of Raster and vector data model; Non spatial data model-Hierarchical model, Relational model, Network model. Hybrid data model – Quad tree and vector topology. Visualization of geographical data. Basic ideas about data visualization. Maps and cartographic communication. Types of thematic maps. Visualization in a GIS.
- GIS Applications in urban planning, groundwater studies, mineral exploration, disaster management, climate change analysis

Essential Reading:

1. Avery, T.E. Interpretation of aerial photographs, Burges Publishing Co 1968
2. Estes, J.W. and Leslie W. Senger, Remote Sensing - Techniques for Environmental analysis, Hamilton Publishing Co., 1974
3. Ravi P Gupta Remote sensing geology, ,2nd edition , Springer, 2003
4. Thomas M. Lilesand, and Ralph W. Keiferr. Remote Sensing and Image Interpretation, John Wiley and Sons 1979
5. Shiv N Pandey, Principles and Applications of Photogeology, New age International Publishers, 2007
6. John R Jesnsen, Remote sensing of the environment, University of Carolina, Pearson Educations
7. Avery, T.E. Interpretation of aerial photographs, Burges Publishing Co 1968
8. Burrow, P. A. and Mc Donnel, R. A. Principles of Geographic Information Systems, Oxford Publishers, 1998
9. Clark, K.C. Getting started with Geographic Information System, Prentice Hall,1990
10. Demer**,** M.N. Fundamentals of GIS, John Wiley & Sons, 2000.
11. ESRI. Understanding Geographic Information System. The Arc lnfo Method, Wiley Publishers
12. Heywood, 1. Cornelius, S. and Canver, S. An introduction to Geographical Information System, Pearson Education Asia Pvt. Ltd. 1993.
13. Peter A. Burrough and Ruchael, A. McDonnell, Principles of Geographical Information System, Oxford Publishers.
14. Star, J. Ester, J. Geographic Information System - An introduction, Prentice Hall,1990

GEL 1C 04 - STRATIGRAPHY AND APPLIED PALAEONTOLOGY

Credits: 4

Course Outcomes

- *The student will be able to explain Stratigraphic principles and evolution, recent developments in stratigraphic classification and major geological events during the different periods of earth history.*
- *The student will be able to illustrate vertebrate paleontology - succession of vertebrate life through geologic time the general characteristics and evolution histories of Dinosaurs, Equus, Elephus and Man.*
- *The student will be able to apply the principles of micropaleontology and palynology in various fields.*

Module 1:

- Stratigraphic principles and evolution. Contributions of Steno, Lehmann, Fushel, Werner, Hutton, Lyell and Smith. Stratigraphic procedures-surface and subsurface procedures.
- Recent developments in stratigraphic classification. 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.

Module 3:

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

Module 4:

- Micropalaeontology - Scope and classification of microfossils.
- Techniques in collection, separation, preparation and preservation of microfossils
- Classification, morphology, ecology, palaeoecology and stratigraphic importance of the following -Foraminifera, Ostracoda, Bryozoa, Radiolaria, Diatoms and Conodonts.

Module 5:

- Palynology: General morphology of spores and pollens–classifications, geological significance and application.
- Application of microfossils in the petroleum exploration, Palaeoenvironments, Palaeoecology and Palaeoclimate. Estimation of Palaeotemperature.

Essential Reading:

1. Arkell, W. J., Jurassic Geology of the World, Oliver and Boyd, 1960
2. Dunbar, CO., and Rogers, J., Principles of Stratigraphy, Wiley, 1961
3. Eicher L.D., Geologic Time, Prentice Hall, 1968
4. Flint, R.F., Glacial and Pleistocene Geology, Wiley, 1961
5. Gignoux M., Stratigraphic Geology, Freeman, 1960
6. Gupta V.J., Cenozoic Stratigraphy of India, Hindustan Publishing House, 1975
7. Gupta V.J., Mesozoic Stratigraphy of India, Hindustan Publishing House, 1976
8. Gupta V.J., Precambrian Stratigraphy of India, Hindustan Publishing House, 1977
9. Hamilton, E. I., Applied Geochronoiogy, I Edn., Academic Press, 1965
10. Key and Colbert, Stratigraphy and Life History, Wiley, 1965
11. Krishnan, M.S., Geology of India and Burma, Higgin Bothams, 1968
12. Kruinbein, W.C., and Sloss L. D., Stratigraphy and Sedimentation, Freeman, 1963
13. Moore R.C., An introduction to Historical Geology, McGraw Hill, 1958
14. Pichamuthu, C. S., Archaean Geology, Oxford I.B.B., 1985
15. Sarkar, S. N., Stratigraphy and Geochronoiogy of Peninsular India, I Edn., Dhanbad Publications, 1968
16. Weller, Stratigraphic Principles and Practice, Harper and Row, 1959
17. Windley, B. F., The Evolving Continents, I Edn., John Wiley, 1977
18. Ramakrishnan & Vaidhyanathan,Geology of India, Geological Society of India Publication, 2008
19. Shrock R.R., Berk Twenhofel W.H. Principles of Invertebrate Palaeontology, McGraw Hill, 1953
20. Colebert H. Edwin, Evolution of the vertebrates, John Wiley and Sons, 1961
21. Biial u. Haq Anne Boersma, Introduction to Marine Micro-Palaeontology, Elsevier, 1998
22. Woods Henry, Invertebrate Palaeontology, Cambridge University Press, 1961

GEL 2C 05 – ADVANCED MINERALOGY

Credits: 4

Course Outcomes:

- *The student will be able to explain the basic laws of crystallography, application of X-ray crystallography and stereographic projection of crystals.*
- *The student will be able to describe the various crystal notations and derivation of the crystal classes with symmetry elements.*
- *The student will be able to distinguish the minerals based on their optical properties such as sign of elongation, order of interference colour and also on conoscopic observations.*
- *The student will be able to discuss the Earth mineralogy.*
- *The student will be able to describe the structure, chemistry, physical, optical characters of important rock forming minerals.*

Module 1:

- Crystallography- Basic laws- Repetition theory and Translation periodicity of crystals. Derivation and determination of point groups. Crystal forms. Space lattice and unit cell. Concept of space group. Stereographic projection of crystals.
- X-ray crystallography- basic principles. X-ray diffractometer. Bragg's law and its application. Calculation of cell dimensions.

Module 2:

- Optical mineralogy - Plane polarized and cross polarized light; Behaviour of isotropic and anisotropic minerals in polarized light. Double refraction, Refractive index and Birefringence. Orientations of nicol prisms of a Petrological Microscope.
- Vibration directions and sign of elongation in minerals. Pleochroism and scheme of pleochroism.
- Interference colours and finding order of interference colours.

Module 3:

- Optical indicatrices of uniaxial and biaxial minerals.
- Conoscopic observations of minerals under petrological microscope: Formation of interference figures; Uniaxial and biaxial interference figures; Determination of the Optic sign of uniaxial and biaxial minerals.
- Determination of Optic axial angle (2V) – Mallards method.

Module 4:

- Crystal Chemistry: Types of bonding in minerals, ionic radii; coordination number (CN). Isomorphism, Polymorphism and its types. Solid solution and exsolution. Mineralogical expression of radioactivity- Metamictisation and pleochroic haloes.
- Earth mineralogy: Average mineralogical composition of crust and mantle.
- Mineral transformations in the mantle with depth.

Module 5:

- Structure, chemistry, physical, optical characters, P-T stabilities and paragenesis of Silicates and Carbonates.

Essential Reading:

1. Dyar, M.D., Gunter, M.E., 2007. *Mineralogy and Optical Mineralogy.* Min. Soc. America, 705p.
2. Demange, M., 2012. *Mineralogy for Petrologists: Optics, Chemistry, and Occurrence of Rock Forming Minerals*. CRC Press (Taylor & Francis Group), 182 p.
3. Nesse, W.D., 2012. *Introduction to Optical Mineralogy.* Oxford University Press; 4 edition, 384p.
4. Pichler, H., Riegraf, C.S., 2011. *Rock-forming Minerals in Thin Section*. Springer, 220 p.
5. Deer, W.A., Howie, R.A., Zussman, J., 2013. *Introduction to the Rock-forming Minerals*. Mineralogical Society of Great Britain & Ireland, 510 p.

GEL 2C 06 - HYDROGEOLOGY

Credits: 4

Course Outcomes

- *The student will be able to explain Origin of water, subsurface movement and vertical distribution of groundwater, and hydrological properties of rocks.*
- *The student will be able to describe the theory of groundwater flow, methods of pump test data analysis and evaluation of aquifer parameters.*
- *The student will be able to demonstrate various water quality parameters using graphical representations.*
- *The student will be able to demonstrate the various methods of groundwater exploration.*
- *The student will be able to describe the types of wells, drilling methods, various problems related to groundwater, and groundwater provinces of India.*

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 and 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 07 - IGNEOUS AND METAMORPHIC PETROLOGY

Credits: 4

Course Outcomes:

- *The student will be able to understand the generation of magma and formation of igneous rocks at different tectonic settings*
- *The student will be able to illustrate the significance of Bowen's reaction principle, textures and structures, phase rule and its applications, and isotopic studies in the study of igneous Rocks.*
- *The student will be able to describe the unary, binary, ternary and quaternary phase diagrams.*
- *The student will be able to describe the classification of igneous rocks under various schemes and also the petrography and petrogenesis of important igneous rock groups.*
- *This course provides a comprehensive knowledge in experimental metamorphic petrology, metamorphism in relation to space and time, and plate tectonics*
- *The student will be able to discuss the equilibrium aspects of metamorphic reactions, phase diagrams and graphic representation of mineral assemblages, and experimental and thermodynamic appraisal of metamorphic reactions.*
- *The student s will be able to illustrate the petrogenetic significance of metamorphic textures and structures, progressive, contact and regional metamorphism of argillaceous, carbonate, basic igneous,and ultramafic rocks.*

Module 1:

- Bowen's reaction principle and reaction series. Major, minor, trace and rare earth element geochemistryof igneous rocks. Significance of isotopic studies in the petrogenesis of igneous rocks.
- Tectomagmatic environment and igneous provinces. 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:
  Ternary systems: Forsterite- Diopside – Silica, Diopside - Anorthite –Forsterite, Diopside - Anorthite –Albite, Albite – Anorthite- Orthoclase, MgO - Al_2O_3 - SiO_2.
- Quaternary system: Diopside- Anorthite- Albite- Forsterite.

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 Carbonatites Anorthosites, Basalts, Ultramafites and Ophiolites, Monomineralic rocks, Alkaline rocks, Pegmatites, Lamprophyres, Granites.

Module 4:

- Equilibrium aspects of metamorphic reactions: Driving force; Variance and Kinds; Exchange reactions.
- Phase diagrams and graphic representation of mineral assemblages; chemographic projections – ACF, AKF, AFM diagrams.
- Metamorphic facies and facies series; Prograde and retrograde metamorphism; Role of fluids in metamorphic reactions.
- Metamorphism in space and time: Plate tectonics and metamorphic processes; Paired metamorphic belts, Archaean and Proterozoic terrains; Extraterrestrial Metamorphism (Impact and Shock Metamorphism); polymetamorphism

Module 5:

- Petrogenetic significance of metamorphic textures and structures.
- Progressive, contact and regional metamorphism of argillaceous, carbonate, basic igneous, and ultramafic rocks.
- Metamorphic differentiation, anatexis and origin of migmatites; regional metamorphism.
- Paired metamorphic belts in reference to plate tectonics.

Essential Reading:

1. Barker, A.J., 1990. *Introduction to Metamorphic Textures and Microstructures.* Blackie, 162p.
2. Bucher, K. and Grapes, R., 2011. *Petrogenesis of Metamorphic Rocks*. Springer-Verlag, Berlin-Heidelberg, 428p.
3. Frost, C.D., Frost, B.R, 2013. *Essentials of Igneous and Metamorphic Petrology,* Cambridge University Press, 336p.
4. Gupta, A.K., 2007. *Petrology and Genesis of Igneous Rocks.* Narosa Publishing House, 496 p.
5. Kretz, R., 1994. *Metamorphic Crystallization.* John Wiley & Sons, 507p.
6. Miyashiro, A., 1978. *Metamorphism and Metamorphic Belts*. 3rd Edition. George Allen & Unwin, London, 492p.
7. Spear, F.S., *Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths.* Mineralogical Society of America, Monograph, 799p.
8. Spry, A., 1974. *Metamorphic Textures.* Pergamon Press Ltd., 350 p.
9. Vernon, R.H., 1983. *Metamorphic Processes: Reactions and Microstructure Development.* George Allen and Unwin, 247P.
10. Vernon, R.H. and Clarke, G.L., 2008. *Principles of Metamorphic Petrology.* Cambridge University Press, 446p.
11. Winter, J.D., 2011. *Principles of Igneous and Metamorphic Petrology*, Prentice-Hall, 728p.

GEL 3C 08 - EXPLORATION GEOLOGY AND APPLIED GEOPHYSICS

Credits: 4

Course Outcomes:

- *The student will be able to describe the methods of surface and subsurface exploration, drilling and its types and methods of ore reserve estimation.*
- *The student will be able to explain the geological, geochemical, geophysical and radiometric exploration methods.*

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 methods. 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
12. Swapan Haldar, Mineral Exploration, Principles and Applications, Elsevier.
13. S.M. Gandhi, B.C. Sarkar, Essentials of Mineral Exploration and Evaluation, Elsevier.

GEL 4C 09 - GEOCHEMISTRY AND SEDIMENTOLOGY

Credits: 4

Course Outcomes:

- *The student will be able to understand the origin and distribution of elements and geochemical characteristics of the earth*
- *The student will be able to describe the chemistry of the universe, stars, nucleosynthesis, origin of the solar system, meteorites.*
- *The student will be able to describe the Laws of thermodynamics and geochemistry of weathering transportation and deposition.*
- *The student will be able to apply the information on heavy minerals in provenance studies.*
- *The student will be able to apply the information on textures and structures in order to understand about the origin of the rocks.*
- *The student will be able to describe sedimentary facies and depositional environments, Lithologies and structures formed in various environments, basin analysis, and the relationship between plate tectonics and sedimentation.*

Module 1:

- Origin and cosmic abundance of elements. Geochemical classification, distribution and Primary differentiation of elements. Geochemical cycle. Trace elements and REE.
- Geochemical constitution of earth's crust, mantle, core, hydrosphere and atmosphere.
- Elementary crystal chemistry and thermodynamics. Laws of thermodynamics Enthalpy, Entropy, Heat capacity, Free energy, and Fugacity. Gibbs phase rule. Eh-pH diagram.

Module 2:

- Introduction to isotope geochemistry. Geochronology and age of the Earth: Law of Radioactivity; Principles of isotopic dating, Decay schemes and Derivation of equation of age.
- Application of Stable isotopes and Unstable isotopes- U-Th-Pb, K-Ar methods of dating the rocks.
- Analytical techniques: Methods based on Flame photometer, Spectrophotometer, Atomic Absorption Spectrometer, Inductively Coupled Plasma - Atomic Emission Spectrometer (ICP-AES) and SHRIMP.

Module 3:

- Sedimentary processes, lithification and diagenesis of siliceous and Carbonate sediments. Elements of Hydraulics - behaviour of particles in fluids.
- Heavy minerals and their significance in Provenance studies. Heavy mineral separation and identification.

Module 4:

- Sedimentary Textures - 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.
- Sedimentary structures: classification, genesis and significance.

Module 5:

- Sedimentary Facies and Depositional environments - Terrestrial, marine and transitional environments. Lithologies and structures formed in various environments. Brief description about Basin analysis. Plate Tectonics and sedimentation.

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. Milner, Sedimentary Petrography, Vol. I and 11; George Allen and Unwin
23. Krumbein and Pettijohn, Manual of Sedimentary petrography.
24. Tucker, Sedimentary Petrology: An introduction. John Willey & Sons, New York, 198 1
25. Gary Nichols, Sedimentology and Stratigraphy, Wiley and Blackwell, 2009
26. S.M. Sengupta, Introduction to Sedimentology, CBS Publishers & Distributors Pvt. Ltd.

GEL 4C 10 - ECONOMIC GEOLOGY

Credits: 4

Course Outcomes

- *The student will be able to illustrate the important properties of ore minerals under the ore microscope.*
- *The student will be able to describe the various theories of ore genesis and association of rock types and ore minerals.*
- *The student will be able to explain the genetic classification of U and Th deposits, Strategic, critical and essential minerals of India, National Mineral Policy of India.*
- *The student will be able to understand various types of mineral deposits and its classification*
- *The student will be able to describe the origin of coal deposits, petroleum formations and gas hydrates and distribution of these fossil fuels in India.*

Module 1:

- Ore, Tenor, grade and specification for minerals.
- Classification of ore deposits - Lindgren and Bateman classifications
- Ore microscope- polishing and mounting of ores. Physical and optical properties of important ore minerals. Textures and structures of ore and gangue minerals.
- Fluid inclusions studies.

Module 2:

- Metallogenic epochs and provinces. Strata bound and stratiform ore deposits - distribution, form, setting and origin. Mineralization at plate boundaries, Ore forming solutions and their migration. Wall rock alteration.
- Major theories of ore genesis. Paragenetic sequences, Zoning, Controls of ore localization.

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:

- Genetic classification of U and Th deposits. Geology and genesis of U deposits of Jaduguda. Pb-Zn deposits of Rajasthan, Cu deposits of Singhbhum and Malanjkhand, East Coast Bauxite, Iron ore deposits of Bailadila and Kudremukh.
- Strategic, critical and essential minerals of India.
- National Mineral Policy of India

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 Hi l l , 1972
16. Tissot, B. P., and Welta, D. H., Petroleum formation and occurrence, Springer Verlag, 1978
17. Van Krcsalon, D.. Coal, Elsevier, 1961

CORE COURSE: GEOLOGY

(PRACTICAL)

GEL 1L 01 - GEOMORPHOLOGY, STRUCTURAL GEOLOGY, APPLIED PALAEONTOLOGY AND GEOGRAPHIC INFORMATION SYSTEM

Credits: 3

Course Outcomes

- *The student will be able to apply the principles of geomorphology, structural geology,applied palaeontology and geographic information system in problem solving and map interpretation.*

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.

GEOGRAPHIC INFORMATION SYSTEM

- Scanned image georeferencing and transformation from Geographic Coordinate System to Projected Coordinate system in Arc GIS.
- Digitization of the georeferenced image in Arc GIS-Reserved forest area, water bodies, road, river ,railway and locations.
- To display the GPS reading points in Arc GIS
- To convert the kml file to layer and to create shape file in Arc GIS
- To create clip & mosaic of the given image in Arc GIS.
- Image classifications in Arc GIS.
    a) Unsupervised classification in Arc GIS
    b) Supervised classification in Arc GIS

GEL 2L 02 –MINERALOGY AND HYDROGEOLOGY

Credits: 3

Course Outcomes

- *The student will be able to apply the theoretical knowledge in solving problems, identification, interpretation and graphical interpretation.*

Mineralogy:

- Identification of mineral specimens based on physical properties.
- Determination of the following optical characters by classical methods:
    - o Order of interference colour
    - o Sign of elongation
    - o Birefringence
    - o Scheme of pleochroism
    - o Optic orientation
    - o Determination of the vibration directions of polariser and analyzer
    - o Extinction and extinction angle determination
    - o Optic sign
    - o Refractive index by Becke line method
    - o Identification of thin sections of important rock forming minerals
- Recalculation of mineral formula from EPMA analysis – Garnet; Pyroxene; Feldspar; biotite; hornblende
- Stereographic projection of holohedral classes of all the systems, pyritohedral, tetrahedral, plagiohcdral classes of Isometric system and Rhombohedral classes of Hexagonal system.
- Calculations of Axial ratios, Zone symbols, Napier's rule, Laws of anharmonic ratio.

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.

GEL 3L 03 –IGNEOUS AND METAMORPHIC PETROLOGY, EXPLORATION GEOLOGY AND APPLIED GEOPHYSICS

Credits: 3

Course Outcomes

- *The student will be able to apply the theoretical knowledge in solving problems, identification, interpretation and graphical interpretation.*

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 alkalilime 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.

Exploration Geology:

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

Applied Geophysics

- Geophysical Resistivity Survey

GEL 4L 04 – GEOCHEMISTRY, SEDIMENTOLOGY AND ECONOMIC GEOLOGY

Credits: 3

Course Outcomes

- *The student will be able to apply the theoretical knowledge in solving problems, identification, interpretation and graphical interpretation.*

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.

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.

ELECTIVE COURSE

(THEORY)

GEL 2E 01a – MINING GEOLOGY AND ENGINEERING GEOLOGY

Credits: 4

Course Outcomes:

- *The student will be able to describe the geological studies and evaluation in planning, design, construction and problems of major civil structures.*
- *The student will be able to describe mining methods, ore dressing, and mineral legislation in India.*

Module 1:

- Mining geology: Planning, exploration, exploratory mining of surfaces and underground mineral deposits (methods and types).
- Mining methods - Alluvial mining-river sand mining, Mining of beach placers, Clay mining, Coal mining, Seabed mining, Exploration of petroleum. Mine waste management.

Module 2:

- Fundamentals of ore dressing: crushing, grinding, sizing, concentration by washing, scrubbing, jigging, tabling, floatation, magnetic and electrostatic separation.
- Mineral legislation in India

Module 3:

- Geological studies and evaluation in planning, design, construction and problems of major civil structures. Elementary concepts of rock mechanics and soil mechanics.
- Site investigation techniques for civil engineering structures, Building stone and aggregate properties.
- Engineering properties of rocks, and soils.

Module 4:

- Dams: parts, types, forces acting on dams and reservoir problems. Geologic aspects of dam investigation.
- Tunnels: parts, classification, ground conditions, geological considerations. Geological and geotechnical aspects of Bridges and Highways.

Module 5:

- Geological hazards and mitigation- landslides and earth quakes. Landslides: classification, analysis of slope stability, monitoring slope movements, hazard zonation mapping.
- Aseismic design of building, Geotechnical case studies of major projects in India.

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. Bell, F.G. Fundamentals of Engineering Geology, Butterworths, 1983

7. Krynine and Judd, Principle of Engineering Geology and Geotectonic, McGraw Hill. 1957
8. Rose, A. W., Hawkes, H. F., and Webb, J. S., Geochemistry in Mineral Exploration, Academic Press
9. Gokhale, K.V.G.K. Principles of Engineering Geology B.S. Publications , 2006
10. S.M. Sengupta, Introduction to Sedimentology, CBS Publishers & Distributors Pvt. Ltd.

GEL 2E 01b - SEISMOLOGY

Credits: 4

Course Outcomes:

- *The student will be able to describe seismology , seismic sources, Seismometry, Seismogram interpretation.*
- *The student will be able to describe Seismology and earth's structure,and Seismotectonics.*

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 5:

- 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 2E 02a - MARINE GEOLOGY

Credits: 4

Course Outcomes:

- *This course will help the students to understand history of Marine Geological studies*
- *Students will be able to explain various topographical features of the sea bottom*
- *Students will be able to describe properties of physical and chemical sea water and its significance*
- *Basic understanding of the marine and coastal processes, deposits and landforms in a geological perspective.*
- *Students will be able to understand general ocean circulation and related events*
- *Students will be able to explain various types of marine sediments and marine mineral deposits.*

Module 1:

- History of Marine geological studies-contribution of Challenger Expedition. Continental margin: features of continental shelf, continental slope and continental rise.
- Sea bottom topography-Submarine canyons, trenches, volcanoes, mid-oceanic ridges and abyssal plains.

Module 2:

- Physical properties of sea water: distribution of temperature, pressure and density. Thermocline, Pycnocline, Halocline.
- Chemical properties of sea water-elements and dissolved gases present in sea water. Salinity and distribution of salinity.

Module 3:

- Marine sediments: Distribution and classification. CCD.
- Marine mineral resources – Mn Nodules, Phosphatic nodules, Gas hydrates; Controlling factors and distribution.

Module 4:

- Coastal processes: waves, currents and tides. Coastal geomorphology, classification of coasts; Coastal erosion. Beach profiling.
- Coastal protection structures -seawalls, jetties, groins. Coastal Regulatory zone (CRZ).
- Sea level Changes and Eustatic changes of sea level: evidences and implications.

Module 5:

- Circulation: general circulation of the atmosphere boundaries - major surface currents of the world oceans, Coriolis effect, Ekman spiral, geostrophic currents, upwelling and sinking, diverging and converging surface water, Thermohaline circulation.
- Coupled ocean atmosphere system. EL Nino southern oscillation (ENSO), LaNina.

Essential Reading:

1. John, L. Mero, Oceanic Mineral resources
2. Ph, H. Kuenen, Marine Geology, John Wiley and Sons.
3. Keith S.Stowe, Ocean Science. John Wiley and Sons
4. Kenneth, J.P., Marine Geology, Prentice Hall Inc., 1982
5. Shepard, F. P., Submarine Geology, Harper and Row Publishers, New York
6. Sverdrup, H. V., et al, The Ocean
7. Trask, P. D., Recent Marine sediments, Dover publications, 1939
8. Weisberg, J., and Parish, R, Introductory Oceanography. .McGraw Hill, 1974
9. William, L. Donn, Meteorology
10. J. P. Riley R. Chester, Chemical Oceanography, Academic Press
11. L. Pickard W. J. Emery, Descriptive Physical Oceanography, Pergamon
12. Colin D Woodroffe, Coasts: Form, Process and Evolution, Cambridge.

GEL 2E 02b - COAL AND PETROLEUM GEOLOGY

Credits:4

Course Outcomes:

- *Basic understanding of the origin and distribution of the coal and petroleum resources with particular reference to their occurrence.*
- *Students will be able to understand different ranks and physical and chemical properties of Coal*
- *Students will be able to understand origin, physical and chemical properties of Petroleum*
- *Students will be able to understand reservoir and trap rocks and migration of Petroleum*
- *Students will be able to understand Geology of the important petroliferous basins in India.*

Module 1:

- Coal: Origin of Coal, sedimentology of coal bearing strata, mode of occurrence of structures associated with coal seams, classification of coal, chemical analysis of coal.

Module 2:

- Coal petrology: Study of Macroscopic and Microscopic constituents of coals.
- Elementary knowledge about the application of reflectance and fluorescence study of coal Basic idea about the coal preparation, carbonization, coal forming epochs in the geological past.
- Methods of Coal prospecting and estimation of its reserves.
- Coal deposits of India and depositional environment of some important coal fields of India. Coal Industry in India.

Module 3:

- Petroleum: Historical development of petroleum geology.
- Physical and chemical properties of petroleum and related substances.
- Surface and subsurface geographic and stratigraphic occurrence of petroleum.

Module 4:

- Origin of petroleum: inorganic and organic theories of source of petroleum.
- Environments and processes of transformation of source material to petroleum hydrocarbons. Migration of petroleum hydrocarbons: primary and secondary migration. Factors causing migration of petroleum.

Module 5:

- Reservoir rocks: characteristics of reservoir rocks and their types. Principles of determination of porosity and permeability.
- Traps: characteristics and classification. Structural, stratigraphic, combination and fluid barrier traps.

- Accumulation of fluid petroleum Exploration: a review of prospecting methods as applied to the exploration of petroleum accumulations.
- Estimation of petroleum reserves: brief outline of methods of estimation of petroleum reserves. Petroleum prospects: Important oil & gas fields and petroleum prospects of India.

Essential Reading:

1. Stutzar,O and NOC, A.C.: Geology of Coal. University of Chicago Press, Chicago.
2. Moor, E.S.(ed): Coal, its properties, analysis, classification, geology, extraction, uses and
3. distribution. John Wiley & Sons.
4. Stach et.al.: Text book of Coal Petrology. Gebruder Borntraegu, Stuttgart.
5. Scott, A.C.: Coal and Coal-bearing Strata: Recent Advances. Geol. Soc. Publ. No.32, Blackwell.
6. Levorson, A.I. Geology of Petroleum.
7. Lanes, K.K. Petroleum Geology.
8. Russel, W.L. Principles of Petroleum Geology
9. Pirson, S.J. Oil Reservoir Engineering.
10. Lalicker, C.G. Principles of Petroleum Geology.

GEL 3E 03a - ENVIRONMENTAL GEOLOGY

Credits: 4

Course Outcomes:

- *Basic understanding of the immediate environment, pollution, EIA, and waste management practices.*
- *The students will be able to explain the hydrologic cycle and theory of plate tectonics as related to natural hazards and earth resources*
- *The students will be able to explain common earth materials and their relationship to environmental hazards*
- *The students will be able to explain how earth processes create hazards to life and property*
- *The students will be able describe the occurrence and formation of earth resources and significant environmental effects caused by their extraction, processing, and use*
- *To describe the major sources of water, soil, and sediment pollution and methods for their management*
- *The students will be able explain the causes and effects of global climate change.*

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 3E 03b - QUATERNARY GEOLOGY

Credits: 4

Course Outcomes:

- *The course offers the introduction to of Quaternary period, its divisions and relative and absolute criteria for quaternary division.*
- *Basic understanding of the geological activities in the Quaternary period. Especially related to climate.*
- *Students will be able to understand Evolution of human and their impact on quaternary climate change also part of the course.*
- *This course will help the students to understanding of the recent geological events such as recent crustal movement and glaciations.*

Module 1:

- Quaternary Geology - an overview. Quaternary environments. Quaternary stratigraphy, lithology, genesis of quaternary deposits, fauna and flora, paleogeography and economic importance of Quaternary resources.

Module 2:

- Major climatic changes during Quaternary period - Ice age, Pleistocene climate. Quaternary sea level changes and coastal geo-morphology. Atmospheric composition, ocean circulation and biological processes during Quaternary.

Module 3:

- Quaternary fluvial, eolian and glacial systems. Paleoenvironments of Quaternary period in India. Evolution of Quaternary land forms in India. Study of lake deposits and laterites of India.

Essential Reading:

1. Holmes, A. : Principles of Physical Geology, ELBS, U.K.
2. Bird, E.C.F: Coastline changes. John Wiley & Sons, New York.
3. Stowe, K. : Exploring Ocean Science: John Wiley, New York.
4. Bloom, A.L.: Geomorphology - A Systematic Analysis of Late Cenozoic Landforms. Prentice- Hall, New Delhi.
5. Wadia et al : Quaternary environments and geoarchaeology of India. Geol. Soc. India, Bangalore.
6. Thornbury, W.D. :Principles of Geomorphology, Wiley Eastern, New Delhi.
7. Vaidyanathan, R. (ed) : Quaternary Deltas of India: Geol. Soc. India, Bangalore.
8. Davis R.A. (ed) Coastal sedimentary environments. Springer Verlag, New York.
9. Ahmad, E. : Coastal Geomorphology of India. Orient Longman, New Delhi.
10. Leeder, M.R. : Sedimentary process and product: George Allen & Unwin, London.

GEL 3E 04a – CLIMATOLOGY AND DISASTER MANAGEMENT

Credits: 4

Course Outcomes:

- *Basic understanding of the various underlying principles of climatology in relation to the processes of Earth, especially in the light of climate change*
- *Students will be able to understand various climate phenomenon including surface wind movements, geostrophic wind, jet streams, precipitations, rainfall, thunderstorm, lightning, cyclones etc.*
- *Students will be able to understand about air masses, fronts and different types of precipitation and condensation process*
- *Students will be able to understand various geographic phenomenon like rainfall, thunderstorm, lightening, tornado and cyclones in detail*
- *This course will help the students to understand hazards and various types disasters*
- *Students will be able to explain natural and manmade disasters*
- *A thorough understanding of the disaster management and its various steps.*

Module 1:

- Structure and composition of the atmosphere – Global warming
- 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 2:

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

Module 3:

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

Module 4:

- Introduction- Hazard and Disaster: Definition and Terminologies. Understanding Natural and Man-made Disasters.
- Hazard, Risk and Vulnerability: Concept and Elements, Risk Reduction Disaster Management: Prevention, Preparedness and Mitigation. Disaster Preparedness Plan.

Module 5:

- Potential hazards in Kerala with special reference to landslides and coastal erosion during the monsoons.
- Cyclone, drought and flood in various parts of India – frequency of occurrence, vulnerable areas- reasons.
- Disaster Management Act-2005.

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
8. Berneard Hauruitz and James, M. Austin, Climatology, Mc Graw Hill publications, Newyork & London.
9. D.S. Lal., Climatology
10. Austin Miller. A., Climatology
11. B.S. Negi., Climatology and oceanography.

GEL 3E 04b - GEOTECHNICAL ENGINEERING

Credits: 4

Course Outcomes:

- *Basic understanding of geo-technical engineering as a field science related to construction.*
- *The student will be able to do field investigations, sampling, field and lab tests, logging and description of soils and rocks.*
- *This course is also helpful in understanding various testing and sampling techniques*

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.

Open elective course to be offered by Geology Department in IIIrd Semester for Other Departments in the University Campus.

ELECTIVE COURSE: THEORY SYLLABUS III SEMESTER

GEL 3E 03c DISASTER MANAGEMENT **Credits: 4**

Course Outcomes:

- Students will be able to understand various Hazards, Disasters, types and its act and policies.
- This course will help the students to understand Earth Quake, Landslides, Avalanches, Volcanic eruptions. Coastal Disasters, Cyclone, Flood, Drought, Tsunami in detail
- Students will be able to explain Hazard, Risk and Vulnerability and capable of making disaster preparedness plan.
- A thorough understanding of the disaster management and its various steps. Also understand the various applications of Science and Technology for Disaster Management.

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: Introduction, prevention, preparedness and mitigation of Earth Quake, Landslides, Avalanches, Volcanic eruptions. 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, 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, coastal erosion, flood, drought, lightning and soil piping.
- Applications of Science and Technology for Disaster Management :Geo-informatics in Disaster Management (Remote Sensing, Geographic Information System and Global Positioning System) **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

8. K.Venu Gopal Rao (2010), Geoinformatics for Disaster Management, Manglam Publi shers And Distributor

QUESTION code (Pages : 2) Name :.....

Reg.No:.....

MODEL QUESTION PAPER FOR P.G. DEGREE EXAMINATION
(CCSS)
Applied Geology
GEL 2C 06 -HYDROGEOLOGY
(2020Admissions)

Time : Three Hours Maximum : 80 Marks

Draw neat diagrams wherever necessary.

Part A

*Write short notes on **all** of the following.*

Each question carries 2 marks.

1.Infiltration galleries.
2.Artesian aquifers.
3.Rain water harvesting.
4.Zone of saturation.
5.Cone of depression.
6.Hydrologic cycle.
7.Porosity.
8.Ground water quality.

Part B

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

Each question carries 6 marks.

9.Concept of groundwater basin
10.Vertical distribution of groundwater
11.Darcy's law and its application
12.Maintenance of wells.
13.Problems of over exploitation and ground water mining.
14.Contamination of groundwater.
15.Explain aquifers and its types.
16.Water table fluctuations.
17.Ghyben-Herzberg relation.
18.Lineament mapping for groundwater exploration

Part C

*Write essays on any **two** of the following.*

Each question carries 14 marks.

19. Explain artificial groundwater recharge methods.
20. Discuss the different subsurface geophysical methods of groundwater exploration.
21.Explain the Causes and preventive measures of saline water intrusion in coastal aquifers.
22.Write an essay on the types of wells and the various drilling methods employed for construction of wells.

QUESTION code (Pages : 2) Name :.....

Reg.No:.....

MODEL QUESTION PAPER FOR P.G. DEGREE EXAMINATION
(CCSS)
Applied Geology
GEL 3C 08 –EXPLORATION GEOLOGY AND APPLIED GEOPHYSICS
(2020 Admissions)

Time : Three Hours Maximum : 80 Marks

Draw neat diagrams wherever necessary.

Part A

*Write short notes on **all** of the following.*

Each question carries 2 marks.

1.Wall rock alteraion
2.Geophones
3.Soil survey
4.Bore hole deviation
5.Litholog
6.Threshold value
7.Define leakage anomaly
8.What is core loss

Part B

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

Each question carries 6 marks.

9.Use of trace elements in exploration.
10.Limitations of self potential surveys in mineral exploration.
11.Describe the use of river sediments in geochemical surveys.
12.Describe the use of sonic logs in exploration.
13.Discuss the primary dispersion of deep seated ores.
14.Describe the use of electrical resistivity surveys in ground water exploration.
15.Explain the advantages of thermal logs.
16.Explain wenner and schlumberger methods.
17.Describe the use of geobotanical indicators in exploration of minerals.
18.Describe the different methods of ore reserve estimation.

Part C

*Write essays on any **two** of the following.*
Each question carries 14 marks.

19. Describe with suitable figures various types of sampling of surface ores.
20. Describe the seismic methods used in exploration of minerals.
21. Discuss the principles and methods employed in radiometric logging.
22. Explain the principles and steps involved in geochemical surveys.

Name……..

Reg. No……..

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2021

MODEL QUESTION PAPER – OPEN ELECTIVE

DISASTER MANAGEMENT

(2020 Admissions)

Time: Three Hours Maximum: 80 Marks

(Instruction: Draw neat diagrams wherever necessary).

Part A (Short Answer)

Answer **all** questions

Each question carries 2 marks

1. Explain Hazard and Disaster.
2. Enumerate Disaster risk reduction and early warning system.
3. Describe Avalanches.
4. Discuss flood and drought.
5. Write about biological disasters.
6. Explain the role of NGO's in disaster response.
7. Write in detail about Global warming.
8. Characterize soil piping. (8 x 2 = 16 marks)

Part B (Short Essay)

Answer any six questions

Each question carries 6 marks

9. Articulate the classification of hazards and disasters.
10. Enumerate Disaster Management Act-2005.
11. Determine the causes and adverse effects of earthquakes.
12. Differentiate Air pollution, water pollution and industrial pollution.
13. Describe the causes and impacts of building fire, coal fire, forest fire and oil fire.
14. Discuss Global warming and climate change.
15. Elaborate Disaster preparedness plan.
16. Classify the role of It and communication in disaster management.
17. Explain the causes and effects of coastal erosion in Kerala.
18. Discuss the role of Geoinformatics in disaster management. (6 x 6 = 36 marks)

Part C

Write essays on **two** of the following
Each question carries 14 marks

19. Give an account of the Institutional and Administrative frameworks for Disaster Management.
20. Describe Landslides as natural disasters highlighting on the causes, adverse effects and preventive measures.
21. Explain the role of various agencies in disaster response.
22. Discuss cyclones and floods as natural disasters in India with suitable examples.

(2 x 14 = 28 marks)