UNIVERSITY OF CALICUT

Abstract

General and Academic IV - Faculty of Science - Modified Scheme and Syllabus of M Sc Applied Geology Programme (CCSS) and Minor courses in Geology for Integrated Programmes offered by Department of Geology, with effect from 2024 admission, in accordance with the Regulations for CCSS in the University Teaching Departments, with multiple entry and exit options (2024) - Implemented- Orders Issued.

G & A - IV - J

U.O.No. 6894/2026/Admn Dated, Calicut University.P.O, 06.05.2026

Read:-1. U.O.No. 13930/2025/Admn dated 07.10.2025

2. Remarks from the Chairperson, Board of Studies in Geology SB dated 07.04.2026.
3. Remarks of the Dean, Faculty of Science dated 02.05.2026.
4. Orders of the Vice Chancellor in the file of even no and dated 06.05.2026.

ORDER

1. The Scheme and Syllabus of M Sc Applied Geology Programme (CCSS) and Minor courses in Geology for Integrated Programmes offered by Department of Geology, in accordance with the Regulations for CCSS in the University Teaching Departments with Multiple entry and exit options (2024) was implemented in the University of Calicut with effect from 2024 Admission, vide paper read as (1).
2. The Board of studies in Geology SB vide paper read as (2), recommended to approve the Modified Scheme and Syllabus of M Sc Applied Geology Programme (CCSS) and Minor courses in Geology for Integrated Programmes offered by Department of Geology, with effect from 2024 admission, after incorporating certain corrections, in tune with the Regulations for CCSS in the University Teaching Departments, with multiple entry and exit options.
3. The Dean, Faculty of Science, vide paper read as (3), approved the recommendation of the Board of Studies in Geology SB.
4. The Vice Chancellor has approved the above recommendation and accorded sanction to implement the modified scheme and syllabus of M Sc Applied Geology Programme (CCSS) and Minor courses in Geology for Integrated Programmes offered by Department of Geology, with effect from 2024 admission, in accordance with the Regulations for CCSS in the University Teaching Departments with Multiple entry and exit options (2024), exercising the powers as per section 10(13) of Calicut University Act 1975.
5. The modified Scheme and Syllabus of M Sc Applied Geology Programme (CCSS) and Minor courses in Geology for Integrated Programmes offered by Department of Geology, in accordance with the Regulations for CCSS in the University Teaching Departments with Multiple

entry and exit options (2024), is Implemented with effect from 2024 Admission.

6. U.O.No. 13930/2025/Admn dated 07.10.2025 stands modified to this extent.
7. Orders are issued accordingly. (Syllabus appended)

Ajayakumar T.K

Assistant Registrar

To

The Head, Department of Geology

Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/JCE I/JCE V/DoA/EX and EG Sections/GA I F/CHMK Library/Information Centres/SF/DF/FC

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Section Officer

UNIVERSITY OF CALICUT

Regulations, Scheme of Evaluation, and Syllabus for

Master of Science (M.Sc.) Programme

in

Applied Geology

For University Teaching Department

(2024 Admission onwards)

Under

Choice Based Credit Semester System – CCSS

&

The Minor Courses in Geology Offered by The Dept. of Geology for the Five-Year Integrated PG (CSS) Programmes

Board of Studies in Geology (Single Board)
University of Calicut

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 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 Basedon 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 of M.Sc. (Applied Geology) programme 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 MOOC Courses.
2) Comprehensive Field work/Study Tour, Mapping Camp, Viva-voce, Industrial Training and Project Work / Dissertation shall be treated as Core Courses.
3) Total credit for the programme shall be 88 (Eighty Eight), this describes the marks of the course concerned and the pattern of distribution as detailed below. A student shall accumulate a minimum of 88 credits for the successful completion of the programme.
4) There shall be University examination for theory and Practical courses at the end of

each semester, to be conducted after the completion of 90 working days . Each examination will be of 3 hour duration.

5) Study tour may be carried out as one of the practical component of Economic Geology during II Semester of the programme. 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.

6) Combined field mapping may be carried out as one of the practical component of Exploration Geology and Geophysics during III Semester of the programme. Mapping camp, shall be carried out, extending for two-to three-weeks in a particular location, anywhere in India with emphasis on structural and lithological mapping as part of geological exploration.

7) Industrial Training may be carried out at any time during the entire period of the programme. Industrial Training, extending for two - to four- Weeks in any industry/institute anywhere in India/out side India with emphasis on geology or earth science as a domain.

8) Evaluation of Project / dissertation and viva-voce shall be conducted at the fourth semester of the programme.

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

Course type	Course code	Course title	Credits	Lecture/ Tutorial/ Practical hours	Marks		
					Internal	External	Total
I SEMESTER (Total Credits: 24)							
CORE COURSE 1	GEL07C501	Physical Geology & Geomorphology	4	3:1	50	50	100
CORE COURSE 2	GEL07C502	Structural Geology & Geotectonics	4	3:1	50	50	100
CORE COURSE 3	GEL07C503	Remote Sensing & Geographic Information System	4	3:1	50	50	100
Elective (Any one among these courses)	GEL07E501	Stratigraphy &Palaeontology	4	4	50	50	100
	GEL07E502	Seismology					
Elective (Open course)	GEL07E503	Disaster Management	4	4	50	50	100
Online Course-1	GEL07M501	Online/MOOC Course 1	4	4		100	100
Total credits of the semester			**24**		**250**	**350**	**600**
II SEMESTER (Total Credits: 20)							
CORE COURSE 4	GEL08C501	Advanced Mineralogy	4	3:1	50	50	100
CORE COURSE 5	GEL08C502	Hydrogeology	4	3:1	50	50	100
CORE COURSE 6	GEL08C503	Economic Geology	4	3:1	50	50	100
Elective (Any one among these courses)	GEL08E501	Marine Geology	4	4	50	50	100
	GEL08E502	Coal & Petroleum Geology					
Online Course -1	GEL08M501	Online/MOOC Course 2	4	4		100	100
Total credits of the semester			**20**		**200**	**300**	500
III SEMESTER (Total Credits: 20)							
CORE COURSE 7	GEL09C601	Igneous & Metamorphic Petrology	4	3:1	50	50	100
CORE COURSE 8	GEL09C602	Sedimentary Petrology	4	3:1	50	50	100
CORE COURSE 9	GEL09C603	Exploration Geology & Applied Geophysics	4	3:1	50	50	100
Elective (Any one among these courses)	GEL09E601	Climatology	4	4	50	50	100
	GEL09E602	Planetary Geoscience					
Elective (Any one among these courses	GEL09E603	Mining Geology & Engineering Geology	4	4	50	50	100
	GEL09E604	Environmental Geology					
Total credits of the semester			**20**		250	250	500

IV SEMESTER (Total Credits: 24)							
Project/ Dissertation	GEL10P601	Dissertation	20			100	100
Online Course -3	GEL10M601	Online/MOOC Course 3	4	4		100	100
Total credits of the semester			**24**			200	200
Courses in substitution to Project work							
CORE COURSE10	GEL10C604	Indian Geological framework and its significance	4	4	50	50	100
CORE COURSE11	GEL10C605	Quaternary Geology	4	4	50	50	100
CORE COURSE12	GEL10C606	Geochemistry	4	4	50	50	100
CORE COURSE13	GEL10C607	Oceanography	4	4	50	50	100
CORE COURSE14	GEL10C608	Meteorology	4	4	50	50	100

Online Courses

Students should earn 4 credits by completing quality assured remote learning modes. Thecredits should be earned either by attending MOOC or Online courses offered on the StudyWebs of Active Learning for Young Aspiring Minds (SWAYAM), UGC MOOC's, NPTEL, edX, Coursera, Udacity, Udemy, Stanford online and courses offered by IIT's, NIT's and IISER.

Guidelines for course selection

- Ensure the online/MOOC course matches your current knowledge level and does not overlap with the Core/Elective courses or Major/Minor of the Programme
- Choose a course that will you to earn four credits
- Assess the time commitment required (hours per week) and ensure it fits your schedule
- Ensure that the courses align with the semester schedule
- Enrollment in the courses should be completed within three weeks from the start of the semester
- Credits should be acquired within the semester
- Course completion certificate has to be produced by the end of the semester
- The same course should not be chosen for different semesters
- Review any prerequisites to conform you have the necessary background
- The courses have to be selected with the assistance of faculty advisor/mentor/department council
- Seek approval from the Department Council:
    - ❖ Prepare a proposal including the course description, syllabus, creditinformation, and how it aligns with your academic goals
- Students who wish to opt for courses from platforms not listed above should seek approval from the Department Council at least 2 weeks before the commencement of the semester. Approval of courses is under the discretion of the Department Council.

7. Evaluation

The evaluation scheme for each course shall contain two parts
(a) Internal evaluation and
(b) external evaluation.
Out of these, 50% marks shall be given to internal evaluation and theremaining 50% 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 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)	Attendance*	5
ii)	Seminar	5
iii)	Assignment	5
iv)	Test Paper	30
v)	Viva - Voce	5
	Total	**50**

*90% and above = 5 marks; 80 to 89% = 3 marks; 75 to 79 = 1 mark; below 75 % = Nil

7.1.1.2. Practical

Sl. No.	Component	Marks
i)	Lab skill/Quality of Record	10
ii)	Practical Test	30
iii)	Viva Voce	10
	Total	**50**

7.1.1.3. Dissertation

Sl. No.	Criteria	Marks
1.	Punctuality	10
2.	Use of Data	10
3.	Scheme/Organization of the Report	60
4.	Viva-Voce	20
	Total	**100**

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 inthe University. Awarding of a higher grade after revaluation may be given only after a second revaluation.

7.2.1. The End Semester practical examination shall be conducted and evaluated by two ormore examiners nominated by the Department Council.

7.2.2 The valuation scheme for Project/Dissertation:

The valuation shall be jointly done by the supervisor of the project in the department and an External / Internal Expert from the approved panel, based on a well-defined scheme of valuation framed by them.

7.3.Pattern of questions for external evaluation

Each theory question paper may contain 10 short notes types of questions out of 10, of marks 1; 6 short essays out of 10 of marks 4; and 2 long essays out of 4, with marks of8 each.

Sl. No.	Type of Questions	Individual marks	Total marks	Number of questions to be answered
1	Short notes type questions	1	10 X 1 = 10	10 out of 10
2	Short essays	4	6 X 4 = 24	6 out of 10
3	Long Essay type questions	8	2 X 8=16	2 out of 4

7.4.Attendance

The students admitted in the PG programmes shall be required to attend at least75 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 theworking 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

No separate minimum is required for internal evaluation for a pass, but a minimum 40%is required for each course in the end semester examination evaluation.

Pass Minimum for a Course = D 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.

7.6 Grading System

Range of Marks (%)	Grade Point	Letter Grade
85 – 100	8.5 - 10.0	O (Outstanding)
75 – 84.99	7.5 - 8.49	A+ (Excellent)
65 – 74.99	6.5 - 7.49	A (Very Good)
55 – 64.99	5.5 - 6.49	B+ (Good)
50 – 54.99	5.0 - 5.49	B (Above Average)
45 – 49.99	4.5 - 4.99	C (Average)
40 – 44	4.0 – 4.49	D (Pass if the student scores minimum 40% in end semester evaluation
0 – 39	0	F (Failed)/ RA(Reappear)
-	0	Ab (Absent)
-	0	I (Course Incomplete)

Remarks: Pass minimum for each course is 40%; and that for aggregate (Internal+Endsemester) is 50% and hence % marks range 0-39 corresponds to the letter grade 'F'.

CORE COURSE:

GEOLOGY

(THEORY)

PROGRAMME OUTCOMES

PO1. Critical Thinking: Take informed actions after identifying the assumptions that frame our thinkingandactions,checkingoutthedegreetowhichtheseassumptionsare 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,mediaandtechnology.

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 andlife-longlearninginthebroadestcontextsocio-technologicalchanges.

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.

GEL07C501 - PHYSICAL GEOLOGY AND GEOMORPHOLOGY

Credits: 3

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 andmass 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

GEL07C502 - STRUCTURAL GEOLOGY AND GEOTECTONICS

Credits: 3

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.
- Concept of stress and strain; Strain and displacement; Graphical representation of finite strain: Strain ellipsoid; Flinn diagram and Mohr Circle.
- Brittle and ductile deformation; Behaviour of minerals and rocks under deformation conditions; Rheology.
- 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.
- 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; shearsense indicators; Mylonites and cataclasites.
- 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.
- 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; Palaeomagnetism and its application for determining palaeoposition of continents.
- Seismic belts of the earth. Geodynamic evolution of the Indian plate - Evolution ofHimalaya 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.* PergamonPress, Inc., 598 p.
7. Marshak, S., Mitra, G., 2018. *Basic Methods of Structural Geology.* Pearson Educations, 446p.
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.

GEL07C503 – REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

Credits: 3

Course Outcomes

- *The student will be able to explain the fundamentals of aerial photography and remotesensing.*
- *The student will be able to discuss electromagnetic spectrum, resolution concepts, varioussensors, and Indian remote sensing satellite missions.*
- *The student will be able to explain the fundamentals of digital image processing andclassification, 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 InformationSystem.*
- *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 aerialphotographs. 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.
- Electromagnetic spectrum
- Principles of Satellite Remote Sensing. Platforms and sensors.
- Resolution concepts- Spatial, Spectral, Radiometric and Temporal resolution. Multi Spectral Scanners (MSS).

Module 2:

- 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.
- **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 3:

- 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 4:

- 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).

Module 5:

- Types of Map-Topographical map, Large scale map, Thematic map. Types of thematic maps. 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- Hierarchicalmodel, Relational model, Network model. Hybrid data model – Quad tree and vector topology.
- Basic ideas about data visualization in GIS. Maps and cartographic communication.
- 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, OxfordPublishers, 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

GEL08C501 – ADVANCED MINERALOGY

Credits: 3

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 ofinterference figures; Uniaxial and biaxial interference figures; Determination of the Optic sign of uniaxial and biaxial minerals.
- Determination of Optic axial angle (2V) – Mallard's 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 common rock-forming 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.

GEL08C502 - HYDROGEOLOGY

Credits: 3

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 water, Hydrologic cycle: precipitation, runoff, infiltration and evapotranspiration, Hydrographs.
- Vertical distribution of groundwater. Springs and its classification. Types of aquifers.
- 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:

- Ground water movement. Darcy's Law and its applications.
- Pump tests – methods. 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 –
- Remotesensing for groundwater exploration.

Module 5:

- Types of wells, drilling methods, construction, design 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.

GEL08C503 - ECONOMIC GEOLOGY

Credits: 3

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 ofimportant 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, saltdomes. 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

GEL09C601 - IGNEOUS AND METAMORPHIC PETROLOGY

Credits: 3

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 metamorphictextures 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, geochemistry of 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 IUGS. 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; variants and types; 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.

GEL09C602 – SEDIMENTARY PETROLOGY

Credits: 3

Course Outcomes:

- *The student will be able to understand the different types of sedimentary rocks, their origin and classification.*
- *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:

- Overview of sedimentary processes- weathering, erosion, transportation and deposition.
- lithification and diagenesis of sediments. :Diagenetic processes and stages of diagenesis.
- Sedimentary rock classification: Clastic, chemical, and biochemical sedimentary rocks.
- Economic significances of sedimentary rocks

Module 2:

- Sedimentary Textures –grain size, shape and sorting.
- Grain size classification, grade scale and sediment classes. Grain size analysis-sieving and pipette analysis.
- Graphic representation of size analysis data; statistical parameters and their geological significance.

Module 3:

- Sedimentary structures: classification, genesis and significance.
- Sediment maturity: Textural and mineralogical maturity
- Applications sedimentary petrology in Provenance studies, Paleocurrent analysis and Paleoenvironmental and paleoclimatic reconstruction.

Module 4:

- 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.

Module 5:

- Heavy minerals: Definition and characteristics.
- Heavy mineral classification and their significance in Provenance studies.
- Heavy mineral separation and identification

Essential Reading:

1 Blatt, R, Middleton, G., and Murray, R., Origin of Sedimentary Rocks, Prentice Hall, 1980

- Carver, R. E. (Ed.), Procedures in Sedimentary Petrology, Interscience, 1971.
- Collins and Thomson, Sedimentary Structures. George Allen & Unwin, London, 1982
- Dickinson, W. R., and H. Yarborough, Plate tectonics and Hydrocarbon accumulation
- Folk, R. I., Petrology of Sedimentary Rocks, Hemphill's University Station, Texas, 1968
- Friedman, and Sanders, Principles of Sedimentology, John Wiley and sons, NewYork
- Hatch and Rastall, Petrology of Sedimentary rocks, Thomas Murby & Co
- Prothero and schwab, Sedimentary Geology, W.I 1. Freeman & Co.
- Reineck and Singh, Depositional sedimentary environment Springer Verlag
- Pettijohn, I J.. Sedimentary Rocks, I larper and Row Pub. New Delhi, 1975
- Peter, K. Weyl, Oceanography An introduction to the marine environment
- Milner, Sedimentary Petrography, Vol. I and 11; George Allen and Unwin
- Krumbein and Pettijohn, Manual of Sedimentary petrography.
- Tucker, Sedimentary Petrology: An introduction. John Willey & Sons, New York, 1981
- Gary Nichols, Sedimentology and Stratigraphy, Wiley and Blackwell, 2009
- S.M. Sengupta, Introduction to Sedimentology, CBS Publishers & Distributors Pvt. Ltd.

GEL09C603 - EXPLORATION GEOLOGY AND APPLIED GEOPHYSICS

Credits: 3

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.
- 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 andsurface waters and sediments.
- Biochemical anomalies. Geobotanical survey techniques. Geobotanical indicators.

Module 2:

- 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 3:

- 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 4:

- 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.

Module 5:

- Drilling and its types.
- Different methods of sampling and assaying.
- Methods of ore reserve estimation.

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, PergamonPress
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.

GEL10C601 – INDIAN GEOLOGICAL FRAMEWORK AND ITS SIGNIFICANCE

Credits: 4

Course Outcomes:

- *The student will be able to describe the tectonic framework of India.*
- *The student will be able to explain the stratigraphy and palaeo environments of India*
- *The student will be able to describe the mineral resources of India.*
- *The student will be able to elucidate the environmental implications of mining and natural hazards of India.*

Module 1:

- Tectonic Framework of India. Precambrian cratons and mobile belts of India
- Himalayan orogeny and its impact on Indian geology
- Indo-Gangetic plain and its geological significance
- Deccan Traps and other volcanic provinces

Module 2:

- Stratigraphy and Paleoenvironments of India.
- Archean and Proterozoic stratigraphy of India
- Paleozoic, Mesozoic and Cenozoic sequences of India
- Quaternary geology, sea-level changes and their paleoclimatic implications

Module 3:

- Economic Geology and Metallic mineral deposits (Fe, Mn, Cr, Cu, Pb-Zn, Au) of India
- Non-metallic mineral resources in India
- Fossil fuel deposits (coal, petroleum, natural gas) in India
- Occurrence of Atomic minerals and rare earth elements in India

Module 4:

- Environmental Geology and Groundwater provinces of India
- Water quality issues and management in India
- Geological hazards (earthquakes, landslides, floods) in India
- Environmental impacts of mining and remediation strategies

Module 5:

- Applied Aspects of Indian Geology. Remote sensing and GIS applications in Indian geology
- Geothermal resources of India and their potential
- Engineering geology for major Indian projects
- Geoarchaeology and cultural heritage sites in India

Essential Reading:

1. Valdiya, K.S. (2016). The Making of India: Geodynamic Evolution. Springer.
2. Kale, V.S. (2014). Geomorphology and Climate of Indian Subcontinent. Elsevier.
3. Ramakrishnan, M., & Vaidyanadhan, R. (2010). Geology of India. Geological Society of India.
4. Sinha, R., & Ravindra, R. (2020). Earth System Processes and Disaster Management. Springer.
5. Bhattacharya, A., & Guha, S. (2018). Exploring Indian Minerals and Gems. Geological Survey of India.
6. Tandon, S.K., & Gupta, P. (2013). Stratigraphy and Paleontology of the Indian Subcontinent. Wadia Institute of Himalayan Geology.
7. Naqvi, S.M., and Rogers, J.J.W. (1987). Precambrian Geology of India. Oxford University Press.
8. Radhakrishna, B.P., & Naqvi, S.M. (1986). Precambrian of South India. Geological Society of India.
9. Biswas, S.K. (2012). Status of Petroleum Exploration in India. Geological Society of India.
10. Pathak, B.D. (2008). Groundwater in India and Its Management. Central Ground Water Board.
11. Jain, S.C., Nair, K.K.K., & Yedekar, D.B. (1995). Geology of the Son-Narmada-Tapti Lineament Zone. Geological Survey of India.
12. Roy, A.B., & Purohit, R. (2018). Indian Shield: Precambrian Evolution and Phanerozoic Reconstitution. Elsevier.

GEL10C602 - QUATERNARY GEOLOGY

Credits: 4

Course Outcomes:

- *Basic understanding of the Quaternary environments and stratigraphy*
- *Students will be able to understand the climatic changes during Quaternary periodand air –sea interaction during Quaternary.*
- *Students will be able to explain Paleoenvironments of Quaternary period.*

Module 1:

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

Module 4:

- 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.

GEL10C603 - GEOCHEMISTRY

Credits: 4

Course Outcomes:

- *The student will be able to understand the origin and distribution of elements andgeochemical characteristics of the earth*
- *The student will be able to describe the Laws of thermodynamics.*
- *The student will be able to explain the isotope geochemistry and its applications*
- *The student will be able to describe analytical techniques in geochemistry.*

Module 1:

- Atomic Structure and Properties of Elements. Cosmic abundance of elements.
- Geochemical Classification of Elements. Geochemical Cycles – Carbon, Oxygen and Water.
- Chemical constitution of the Earth's crust, mantle, core, hydrosphere and atmosphere

Module 2:

- Laws of Thermodynamics – Zeroth, First, Second and Third
- Enthalpy, Entropy, Heat capacity, Free Energy and Fugacity.
- Gibbs phase rule. Eh-pH diagram

Module 3:

- Introduction to Isotope Geochemistry. Radioactive decay schemes. Decay constant, half life, parent-daughter relations.
- Geochronology and age of earth. Law of Radio activity. Principle of isotope dating. Decay schemes and derivation of equation of age.
- Principles of isotope fractionation, Stable isotopes and unstable isotopes. U-Th-Pb, K-Ar, Rb-Sr, Sm-Nd method of dating. Carbon dating

Module 4:

- Analytical Techniques in Geochemistry -sample collection, storage and analysis procedures
- Analytical Instruments, X-ray fluorescence (XRF) and X-ray diffraction (XRD), Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Atomic Absorption Spectroscopy (AAS), Electron microprobe analysis, Inductively Coupled plasma Atomic Emission Spectrometry (ICP-AES) Laser ablation and secondary ion mass spectrometry (SIMS)

Module 5:

- Applied Geochemistry, Atmospheric and ocean geochemistry, Biogeochemistry and microbial geochemistry
- Exploration geochemistry and ore deposits, Petroleum geochemistry, Geochemistry of climate change, Geochemistry in planetary science

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.

GEL10C604 - OCEANOGRAPHY

Credits: 4

Course Outcomes

- *The student will be able to illustrate the physical oceanographic characteristics and processes.*
- *The student will be able to describe the Chemical oceanographic fundamentals.*
- *The student will be able to explain the biologic components of oceanography.*
- *The student will be able to understand geological oceanography.*
- *The student will be able to describe the applications of oceanography.*

Module 1:

- Physical Oceanography. Ocean structure and properties. Temperature, salinity, density, and their distributions.
- Oceanic circulation and currents. Surface currents, deep currents, gyres, and their role in climate. Ocean-atmosphere interactions.
- Ocean Waves-Types, generation, propagation. Ocean Tides: Tidal forces, types of tides, tidal prediction.
- Coastal Processes: Waves, tides, currents, and their impact on coastal morphology.

Module 2:

- Chemical Oceanography. Seawater composition and properties. Major and minor elements, their distribution, and cycling.
- Marine biogeochemical cycles. Carbon, nitrogen, phosphorus, and oxygen cycles in the ocean.
- Ocean acidification and carbon cycle. Causes, effects, and mitigation strategies.
- Trace elements and isotopes in the ocean

Module 3:

- Biological Oceanography. Marine ecosystems and biodiversity. Pelagic, benthic, and coastal ecosystems. Marine Organisms: Classification, adaptations, and distribution.
- Primary production and marine food webs. Trophic levels, energy flow, and biogeochemical cycles.
- Plankton ecology and dynamics. Phytoplankton, photosynthesis, and factors affecting it.
- Marine microbiology and biogeochemistry. Marine Biodiversity: Threats, conservation, and sustainable management.

Module 4:

- Geological Oceanography. Plate tectonics and ocean basin formation
- Marine sedimentology and stratigraphy
- Paleoceanography and climate change
- Coastal geomorphology and processes

Module 5:

- Applied Oceanography. Remote sensing and ocean observing systems
- Marine resources and management
- Ocean pollution and conservation
- Climate change impacts on oceans

Essential Reading:

1. Talley, L.D., Pickard, G.L., Emery, W.J., & Swift, J.H. (2011). Descriptive Physical Oceanography: An Introduction. Academic Press.
2. Libes, S.M. (2009). Introduction to Marine Biogeochemistry. Academic Press.
3. Miller, C.B., & Wheeler, P.A. (2012). Biological Oceanography. Wiley-Blackwell.
4. Garrison, T. (2012). Essentials of Oceanography. Cengage Learning.
5. Thurman, H.V., & Trujillo, A.P. (2016). Introductory Oceanography. Pearson.
6. Sarmiento, J.L., & Gruber, N. (2006). Ocean Biogeochemical Dynamics. Princeton University Press.
7. Pinet, P.R. (2019). Invitation to Oceanography. Jones & Bartlett Learning.
8. Kump, L.R., Kasting, J.F., & Crane, R.G. (2013). The Earth System. Pearson.
9. Steele, J.H., Thorpe, S.A., & Turekian, K.K. (Eds.). (2009). Elements of Physical Oceanography: A derivative of the Encyclopedia of Ocean Sciences. Academic Press.
10. Kennish, M.J. (2019). Practical Handbook of Marine Science. CRC Press.
11. Open University Course Team. (2001). Ocean Circulation. Butterworth-Heinemann.
12. Lalli, C.M., & Parsons, T.R. (1997). Biological Oceanography: An Introduction. Butterworth-Heinemann.

GEL10C605 - METEOROLOGY

Credits: 4

Course Outcomes

- *The student will be able to illustrate the Atmospheric characteristics*
- *The student will be able to describe the Circulations and patterns.*
- *The student will be able to explain the weather systems and their evolution.*
- *The student will be able to understand atmospheric processes.*
- *The student will be able to describe the applications of meteorology.*

Module 1:

- Atmospheric Physics and Thermodynamics. Atmospheric composition and structure
- Radiation and radiative transfer. Temperature, pressure, and hydrostatic equilibrium
- Atmospheric thermodynamics and stability. Moisture and precipitation processes

Module 2:

- Atmospheric Dynamics. Forces in the atmosphere. Equations of motion and continuity
- Atmospheric circulation patterns. Atmospheric stability and convection
- Atmospheric waves and oscillations

Module 3:

- Synoptic Meteorology. Weather observations and analysis
- Weather systems and their evolution. Tropical meteorology and cyclones. Extratropical meteorology and jet streams
- Weather forecasting techniques and applications

Module 4:

- Atmospheric electricity and thunderstorms
- Cloud formation and classification. Cloud microphysics and precipitation mechanisms
- Radar meteorology principles and applications
- Lightning detection and analysis

Module 5:

- Applied Meteorology. Aviation meteorology
- Agricultural meteorology. Marine meteorology. Remote sensing in meteorology
- Environmental meteorology and air quality

Essential Reading:

1. Wallace, J.M., & Hobbs, P.V. (2006). Atmospheric Science: An Introductory Survey. Academic Press.
2. Holton, J.R., & Hakim, G.J. (2012). An Introduction to Dynamic Meteorology. Academic Press.
3. Ahrens, C.D. (2018). Meteorology Today: An Introduction to Weather, Climate, and the Environment. Cengage Learning.
4. Houze Jr., R.A. (2014). Cloud Dynamics. Academic Press.
5. Stott, P.J., & Andrews, D.G. (2015). Fundamentals of Meteorology: An Observational Approach. Wiley-Blackwell.
6. Lamb, H.H. (1995). Climate, History and the Modern World. Routledge.
7. Bluestein, H.B. (1992). Synoptic-Dynamic Meteorology in Midlatitudes. Oxford University Press.
8. Petty, G.W. (2006). A First Course in Atmospheric Radiation. Sundog Publishing.
9. Battan, L.J. (1984). Fundamentals of Meteorology. Prentice-Hall.
10. Ackerman, S.A., & Knox, J.A. (2015). Meteorology: Understanding the Atmosphere. Jones & Bartlett Learning.

CORE COURSE:

GEOLOGY

(PRACTICAL)

GEL07C5 01(P) – PHYSICAL GEOLOGY AND GEOMORPHOLOGY (PRACTICAL I)

Credits: 1

Course Outcomes

- *The student will be able to apply the principles of physical geology and geomorphology in problemsolving, feature identification and map interpretation.*

Practical Topics:

- Toposheet interpretation-
- Identification of map scale,
- Contour interpretation,
- Symbol recognition and legend explanation
- Calculation of surface area and slope.
- Study of drainage pattern and its analysis
- Morphometric analysis – linear, aerial and relief parameters.
- Identification of land forms using topo sheets
- Elevation change mapping
- River profiling using topographic maps
- Watershed delineation

GEL07C5 02(P) – STRUCTURAL GEOLOGY AND GEOTECTONICS (PRACTICAL II)

Credits: 1

Course Outcomes

- *The student will be able to apply the principles of structural geology and geotectonics in problemsolving and map representation.*

Practical Topics:

- Interpretation of geologic maps.
- Trigonometric, graphic solutions to problems in structural geology.
- Geometric analysis of planar and linear structures.
- Fabric diagrams
- Rose diagrams and histograms
- Stereographic projections of linear, planar and intersections
- Calculation of dip, strike and plunge
- Identification of folds and faults from geological maps

GEL07C5 03(P) – REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM (PRACTICAL III)

Credits: 1

Course Outcomes

- *The student will be able to apply the principles of remote sensing and GIS in map making and analysis.*

Practical Topics:

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

    a) Unsupervised classification in GIS

    b) Supervised classification in GIS

GEL08C501 (P) –ADVANCED MINERALOGY (PRACTICAL IV)

Credits: 1

Course Outcomes

- *The student will be able to identify minerals in hand specimen and under microscope,*
- *Student will be able to distinguish optical characteristics of minerals.*
- *Student will be able to draw projection diagrams of crystal systems*

Practical Topics:

- Identification of mineral specimens based on physical properties.
- Determination of the following optical characters by classical methods:
  - ✓ Order of interference colour
  - ✓ Sign of elongation
  - ✓ Birefringence
  - ✓ Scheme of pleochroism
  - ✓ Optic orientation
  - ✓ Determination of the vibration directions of polariser and analyzer
  - ✓ Extinction and extinction angle determination
  - ✓ Optic sign
  - ✓ Refractive index by Becke line method
  - ✓ Identification of thin sections of important rock forming minerals
- 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.

GEL08C502 (P) –HYDROGEOLOGY
(PRACTICAL V)

Credits: 1

Course Outcomes

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

Practical topics:

- Calculation of Porosity, permeability, void ratio and Darcy's Law.
- Computation of aquiferparameters from pump test data.
- Graphical representation of hydro chemical data –
- Piper trilinear diagram,
- USSL Diagram,
- Stiffs diagram.
- Calculation of specific yield
- Calculation of specific retention

GEL08C5 03(P) – ECONOMIC GEOLOGY
(PRACTICAL VI)

Credits: 1

Course Outcomes

- *The student will be able to apply the geologic principles in identifying features in the real world scenario.*
- *The student will be able to explain the extraction of mineral resources by mining.*
- *The student will be able to identify various economic minerals and its significance..*

Practical Topics:

(A) Laboratory Practices

- Megascopic Identification of important economic minerals.
- Microscopic Identification of economic minerals
- Identification of major ore minerals
- Calculation of grade of minerals

(B) Field Practices

- Field-based study, including visit to quarries and mines of economic mineral deposits.
- Understand the geologic settings of ore deposits and occurrence of economic minerals
- Identification of geological structures and landforms in the field.
- Visit to locations of geological interest.
- Visit to geological Academic/Research institutions.

GEL09C601 (P) – IGNEOUS AND METAMORPHIC PETROLOGY (PRACTICAL VII)

Credits: 1

Course Outcomes

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

Practical Topics:

- Megascopic and microscopic identification and interpretation of igneous and metamorphic rocks.
- Determination of modal composition, Calculation of norm.
- Niggli values. Variation diagrams Harker. Calculation of Differentiation index.
- Identification of metamorphic mineral paragenesis in hand specimens and thin sectionsand 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, Forsterite - silica.

GEL09C602 (P)- SEDIMENTARY PETROLOGY (PRACTICAL VIII)

Credits: 1

Course Outcomes

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

Practical Topics:

- Grain size analysis – Sieving and Pipette analysis
- Calculation and plotting of sieve analysis data.
- Calculation of Statistical Parameters and interpretation of geologic significance.
- Sediment classification Folk and Ward.
- 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.

GEL09C603 (P) - EXPLORATION GEOLOGY AND APPLIED GEOPHYSICS (PRACTICAL IX)

Credits: 1

Course Outcomes

- *The student will be able to apply the theoretical knowledge in solving problems, interpretation of geology through geophysical techniques.*

Practical Topics:

(A) Laboratory Practices

- Problems in averaging assays.
- Estimation of ore reserves – Cut-off grade.
- Geophysical Resistivity Survey and interpretation of data.

(B) Field Practices

- Combined field mapping to identify and map features and terrain details of an area as a part of geological exploration.

ELECTIVE COURSE

(THEORY)

GEL07E501 - STRATIGRAPHY AND 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

GEL07E502 – SEISMOLOGY

Credits: 4

Course Outcomes:

- *This course will help the students to understand the earthquakes and seismic waves that move through and around the Earth*
- *Students will be able to seismometry and its interpretations.*
- *Students will be able to identify, understand and interpret the seismotectonic studies andthe prediction of earth quakes.*

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 bysingle 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.

GEL08E501 - 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 ridgesand 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.

GEL08E502 - COAL AND PETROLEUM GEOLOGY

Credits:4

Course Outcomes:

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

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.

GEL09E601 – CLIMATOLOGY

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*

Module 1:

- Structure and composition of the atmosphere.
- GHGs,Global warming, Climate Change.

Module 2:

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

Module 3:

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

Module 4:

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

Module 5:

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

Essential Reading:

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

GEL09E602 – PLANETARY GEOSCIENCES

Credits: 4

Course Outcomes:

- *This course will help the students to understand the origin and evolution of thesolar system*
- *Students will be able to explain mechanism of climate change in planetaryatmospheres*
- *Students will be able to describe origin and internal evolution of planets*
- *Basic understanding of geology and geophysics of terrestrial planets and theirsatellites*
- *Students will be able to understand extra-terrestrial impacts and planetaryexploration missions*

Module 1:

- The origin and evolution of Solar System: major concepts, planets, satellites, asteroids,meteorites and comets; formation and internal differentiation of the planets.
- General features of Terrestrial and Jovian planets; introduction to planets and planetarysystems, internal structure of planets and their satellites.

Module 2:

- The general circulation regimes, hydrodynamic instabilities, modeling of planetary atmosphere, climate of Venus, Mars.
- Mechanism of climate change in planetary atmospheres. Atmospheres of Exoplanets.

Module 3:

- Planetary atmospheres: exo- and endogenic processes associated with origin and internal evolution of planets-planetary volcanism, craters, impact catering processes, elemental composition.
- Mineralogy and petrology; thermal, seismic and magnetic properties, and chronological techniques.

Module 4:

- Detailed geology of Mars and Moon as revealed by different missions.

Module 5:

- Physical properties , composition, mineralogy and petrology of the air less rocky bodies: the moon and its terrestrial analogues, minor bodies such as asteroiods, comets, and meteorites.
- Past, present and future planetary exploration missions.

Essential Reading:

1. Angelo P. Rossi, Stephan Gasselt.2018, Planetary Geology, Springer Praxis Books (PRAXIS)
2. Claudio Vita-Finzi, Dominic Fortes.2013, Planetary Geology: An introduction(2nd edi),Dunedin.
3. Gunter Faure, Teresa M. Mensing.2007, Introduction to Planetary Science: The GeologicalPerspective, Springer
4. Ronald Greeley, 2013, Introduction to Plane+tary Geomorphology, Cambridge UniversityPress.

GEL09E603 – MINING GEOLOGY AND ENGINEERING GEOLOGY

Credits: 4

Course Outcomes:

- *The student will be able to describe the geological studies and evaluation inplanning, design, construction and problems of major civil structures.*
- *The student will be able to describe mining methods, ore dressing, and minerallegislation 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 ofmajor civil structures.
- Site investigation techniques for civil engineering structures.
- Engineering Geology-Role of Geology in civil engineering. Engineering properties ofRocks and Soils.

Module 4:

- Dams: parts, types, forces acting on dams and reservoir problems. Geologic aspects ofdam investigation.
- Tunnels: parts, classification, ground conditions, geological considerations. Geologicaland 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 Geotechniques, 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.
11. Abzalor,M., (2016), Applied Mining Geology, Springer International publishing
12. Young G.J.,(1946), Elements of Mining, McGraw-Hill
13. Waltham T.1994, Foundations of Engineering Geology, Spon Press

GEL09E604 - 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 Environmental consequences of natural hazards*
- *The students will be able to understand Pollution studies*
- *The students will be able to explain how earth processes create hazards to life and property*
- *The students will be able understand Hazard and Disaster*
- *The students will be able explain the Potential hazards in Kerala.*

Module 1:

- The physical environment of earth. Natural resources: conservation and preservation. Soil conservation and land use planning. Concept of sustainable development. Geologists' role in environmental management and planning. Interaction between human and nature
- Environment impact Assessment (EIA).

Module 2:

- Environmental consequences of natural hazards like earthquakes. Landslides andvolcanic activity.
- Urban development. Solid waste disposal – source, method of disposal and management. Waste created by human activity such as mining and industrial activities
- Mangroves – classification, types and adaptation. Geographical distribution andimportance.

Module 3:

- Pollution studies - Air and Water pollution - source, types and controllingmeasures.
- Ground water pollution -controlling measures, treatment, detoxification and biodegradation. Health hazards due to ground water pollution.
- Marine pollution- Causative factors: land based sources, marine based sources. Types of pollution and oil spills.

Module 4:

- Introduction- Hazard and Disaster: Definition and Terminologies. UnderstandingNatural 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 erosionduring the monsoons.
- Cyclone, drought and flood in various parts of India – frequency of occurrence,vulnerable areas- reasons.

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.
5. Abbot.P.C (2002): Natural Disaster, McGraw Hill Publications New Delhi
6. Coates.D.R (1985) Geology & Society – Chapman & Hall Publishers New Delhi
7. Davis et.al (1976) Environmental Geosciences – Wiley Eastern
8. Howard A.D & Irwin Remson (1978) – Geology in Environmental Planning –McGraw Hill Publishers

Open elective course to be offered by Department of Geology in Ist Semester for Students from Other Departments in the Calicut University Campus.

OPEN ELECTIVE COURSE:

THEORY SYLLABUS

I SEMESTER

GEL07E503 DISASTER MANAGEMENT

Credits: 4

Course Outcomes:

- *Students will be able to understand various Hazards, Disasters, types and its act andpolicies.*
- *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. Alsounderstand 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'sElements, 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, Airaccidents, 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 inDisaster 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 shersand Distributor

OUTCOME BASED EDUCATION QUESTION PAPER'S: GEOLOGY

(THEORY)

QUESTION code: Name :…….
Reg.No:……

MODEL QUESTION PAPER FOR P.G. DEGREE EXAMINATION(CCSS)

Applied Geology

GEL07C501- PHYSICAL GEOLOGY AND GEOMORPHOLOGY

(2024 Admission onwards)

Time: Three Hours Maximum: 50 marks

Draw neat diagrams wherever necessary.

Part A

*Write short notes on **all** of the following.*
*Each question carries **1** mark.*

1. Theory of uniformitarianism
2. Heat flow of the Earth
3. Geothermal Gradient
4. Wadis
5. Geomorphic cycle by Penck
6. List major theories of evolution of Earth
7. Wetlands
8. Differentiate geoid and spheroid
9. Fluvioglacial deposits
10. Isostasy

Part B

*Write short essays on any **six** of the following.*
*Each question carries **4** marks.*

11. Write a detailed note on features of oceanic and continental crust
12. Explain gravity anomaly. Differentiate between positive and negative gravity anomalies
13. Prepare a note on geomorphological conditions of Kerala. Examine morphometric analysis of drainage basin with diagram
14. Discuss soil profile and depict soil types of Kerala
15. Differentiate between Reynolds number and Froude's number
16. Give a detailed note on types of wetlands and specify how wetlands are conserved in India
17. Discuss about various erosional and depositional features of desert

18. Differentiate the cyclic theories of Penck and Davis
19. List the geomorphic principles and major processes
20. Examine the applications of geomorphology in various fields

Part C

*Write essays on any **two** of the following.*
*Each question carries **8** marks.*

21. Explain the concept of pediplanation and rejuvenation of the drainage system.Prepare anote on fluvial landforms.
22. Explain geomagnetism and geothermal gradient.Summarise about Earth's magnetic field.
23. Construct a concept sketch describing the main landforms and processes for the following:rivers (meandering and braided); glaciers(alpine and continental).
24. Describe physico-chemical and seismic properties of earth's interior. Elaborate on plate tectonics.

QUESTION code: Name :…….

Reg.No:……

MODEL QUESTION PAPER FOR P.G. DEGREE EXAMINATION

(CCSS)

Applied Geology

GEL07C503 – REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

(2024 Admission onwards)

Time: Three hours Maximum: 50 marks

Draw neat diagrams wherever necessary.

Part A

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

*Each question carries **1** marks.*

1. Mobile GIS
2. Remote sensing
3. Name the different Elements of photo interpretation.
4. Explain Microwave Remote Sensing.
5. Discuss the Fundamentals of digital image processing.
6. Discuss about Data sources.
7. Name the different types of Map.
8. Explain FCC
9. Define lineaments
10. Describe the scale of Photographs

Part B

*Write short essays on any **six** of the following.*
*Each question carries **4** marks.*

11. Write a detail note on Electromagnetic spectrum.
12. Compare the differences between Spatial and Non spatial data
13. Assessment of Various Applications of remote sensing in mineral exploration,geomorphology and ground water exploration.
14. Discuss about the Principles and applications of thermal detectors.
15. Figure out the various Advantages and Disadvantages of Raster and vector data model.
16. Basic ideas about data visualization, summarize your views.
17. Explain Microwave Remote Sensing.
18. Identify the various Resolution concepts in detail.

19. Explain the various Indian remote sensing satellite missions.
20. Give an account of multi spectral scanners.

Part -C

*Write essays on any **two** of the following.*
*Each question carries **8** marks.*

21. Give an outline about Image classification and accuracy assessment. Specify the supervised & unsupervised classification in GIS.
22. Explain the Fundamentals of digital image processing and prepare a note on its classifications.
23. Discuss about the history of GIS, and give an outline about the Five fundamental functionalities of a desktop GIS.
24. Specify the various GIS Applications in urban planning, groundwater studies, mineral exploration and disaster management

QUESTION code: Name :…….
Reg.No:……

MODEL QUESTION PAPER – OPEN ELECTIVE(CCSS)

GEL07E503C DISASTER MANAGEMENT

(2024 Admission onwards)

Time: Three hours Maximum: 50 marks

Draw neat diagrams wherever necessary.

Part A

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

*Each question carries **1** 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. Describe sea level rise
9. Write a note on nuclear disasters
10. Discuss about soil piping

Part B

*Answer any **six** questions*

*Each question carries **4** marks*

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

Part C

*Write essays on **two** of the*
followingEach question
*carries **8** marks*

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

Master of Science (M.Sc.) Programme

in

Applied Geology

For University Teaching Department

(2024 Admission onwards)

Under

Choice Based Credit Semester System – CCSS

LIST OF MINOR COURSES

UNIVERSITY OF CALICUT

Board of Studies in Geology (Single Board)

University of Calicut

PROGRAMME OUTCOMES

PO1. Critical Thinking: Takeinformedactionsafteridentifyingtheassumptionsthat frameourthinking 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, mediaandtechnology.

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-longlearninginthebroadestcontextsocio-technologicalchanges.

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.

UNIVERSITY OF CALICUT DEPARTMENT OF GEOLOGY

MINOR COURSES

CCSS FYUGP 2024

Minor courses: 06 **Credits: 24**

SEMESTER 1

Course Code	Course Title	Type of Course	No. of Credits	Level
GEL01C101	Understanding the Earth	Minor	4	100
GEL01C102	Basics of Remote Sensing	Minor	4	100

SEMESTER 2

Course Code	Course Title	Type of Course	No. of Credits	Level
GEL02C101	Earth processes: Exogenetic and endogenetic	Minor	4	100
GEL02C102	Basics of Geographic Information System	Minor	4	100

SEMESTER 3

Course Code	Course Title	Type of Course	No. of Credits	Level
GEL03C201	Understanding Subsurface Water Resources	Minor	4	200
GEL03C202	Advanced Geoinformatics	Minor	4	200

Total credits= 4+4+4+4+4+4= 24 credits

SEMESTER I

GEL01C101 - UNDERSTANDING THE EARTH

Course Outcomes:

- *Student will be able to acquire the fundamental understanding of the Geology and its various branches*
- *Student will be able to understand Earth and its dimension, internal structure and processes*
- *Student will be able to explain the weathering and soil formation, plate tectonics and process related to plate tectonics*
- *Student will be able to recognize minerals and rocks on earth and also to describe geological structures and hydrological cycle.*

Module 1:

- Introduction to geology: Definition and Scope
- Age of the earth and geological time scale
- Introduction to various branches of Geology. Application of Geology in various fields.

Module 2:

- Origin of earth: Big Bang theory and nebular hypothesis
- Basic facts about earth: size, shape, volume, density, rotation and revolution of earth
- A brief outline about the internal structure of the Earth: Crust, mantle, core, lithosphere, asthenosphere. Atmosphere and Hydrosphere.

Module 3:

- Introduction to geomorphic processes: Exogenetic and Endogenetic processes
- Introduction to weathering, soil formation and mass wasting
- Plate tectonics: continental plates, oceanic plates, major plates, minor plates; type of plate boundaries

Module 4:

- Introduction to minerals: Rock forming minerals, ore minerals and industrial minerals
- Petrology: definition; Broad classification of rocks-Igneous rock, metamorphic rocks and sedimentary rocks
- Rock cycle

Module 5:

- Geological structure and structural geology: definition, attitude of beds, strike and dip
- Definition and classifications of major geological structures such as fold, fault, joints and foliation in rocks
- Hydrological cycle; introduction to ground water and hydrogeology

Reference Books

1. Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.
2. Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.
3. Lutgens, F., Tarbuck, E., and Tasa, D., (2009). The Atmosphere: An Introduction to Meteorology. Pearson Publishers
4. Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman and Company, New York.
5. Schoch, R.M. (1989). Stratigraphy, Principles and Methods. Van Nostrand Reinhold
6. Prothero, D.R. (1998). Bringing fossils to life - An introduction to Palaeobiology, McGraw Hill

GEL01C102 - BASICS OF REMOTE SENSING

Course Outcomes:

- *Student will be able to acquire the fundamental understanding of the Remote Sensing and aerial photographs*
- *Student will be able to understand electromagnetic spectrum and its interaction with atmosphere and earth's surface features*
- *Student will be able to explain various types of sensors, spectral signatures and scanners used in remote sensing*
- *Student will be able to understand different types of satellite orbits and use of GPS*

Module 1

- Brief History and development of Remote Sensing; Geometry and types of aerial photographs; Scale of photographs
- Tilt and Height displacement, Vertical exaggeration, Stereoscopy, Mosaics
- Elements of photo interpretation - tone, texture, shape, association, pattern. Photogrammetric Instruments

Module 2

- Electro Magnetic Spectrum, Energy Source – EMR, Blackbody radiation concept
- Interaction of EMR with atmosphere, Atmospheric windows
- Interaction of EMR with earth's surface features

Module 3

- Classification of sensors
- Resolution of sensors– spatial, spectral, radiometric, temporal
- Atmospheric sensors, SONAR, LiDAR, RADAR
- Spectral signatures

Module 4

- Types of platforms – Groundborne, Airborne (balloons, aircrafts, UAV), Spaceborne (sunsynchronous, geosynchronous)
- Scanning Systems- push broom, wisk broom
- Orbital elements, Types of satellite orbits – Sunsynchronous, Geostationary

Module 5

- Global positioning Systems, GNSS, GAGAN
- Uses of GPS, DGPS
- Indian remote sensing satellite missions

References:

1. Introduction to Remote Sensing by James B. Campbell and Randolph H. Wynne (Guilford Press, 2011)
2. Remote Sensing and Image Interpretation by Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman (Wiley, 2015)
3. Fundamentals of Remote Sensing by George Joseph., (Universities Press, 2005)
4. Remote Sensing Digital Image Analysis by John A. Richards., (Springer, 2013)
5. GNSS Applications and Methods by Scott Gleason and Demoz Gebre-Egziabher., Artech House, 2009)
6. Remote Sensing and Image Interpretation by Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman., (Wiley, 2015)

SEMESTER-II

GEL02C101 - EARTH PROCESSES: EXOGENETIC AND ENDOGENETIC

Course Outcomes:

- Student will be able to develop a scientific understanding exogenic and endogenic processes
- Student will be able to understand the geological work of different geological agents and the land forms developed by their action.
- Student will be able to explain earthquake mechanism and volcanic activity
- Student will be able to describe the brief introduction to isostasy , orogenic and epirogenic movements.

Module 1:

- Exogenic processes: Geomorphic agents; River, Glacier, Coastal waves and ground water
- Geological work of streams; Ersion, transportation and deposition. Fluvial erosional and depositional land forms
- Geological work of wind; Aeolian erosional and depositional landforms

Module 2:

- Geological work of glaciers; Ersion, transportation and deposition. Glacial erosional and depositional land forms
- Coastal processes; geological work of waves;erosion, transportation and deposition
- Coastal erosional landforms and coastal depositional land forms

Module 3:

- Geological work of ground water; Ersion, transportation and deposition.
- Kast topography
- Cave deposits- stalactite and stalagmite

Module 4:

- Endogenous processes; Earthquakes, volcanism and orogeny
- Volcanoes, parts, products; volcanic gas, lava, ash, pyroclastic materials
- Volcano classification; based on frequency of eruption, mode of eruption and forms, structure and copmposition

Module 5:

- Earthquakes; terminologies, causes and mechanism
- Classification and measurement of earthquakes
- Orogeny and epirogeny. Isostasy concept

Reference Books.

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, New Delhi, 1976
8. Pethick, J., An introduction to coastal geomorphology, Arnold Heinman publishers, New Delhi, 1984
9. Schumm, S .A. (Ed), Drainage Basin morphology- In Bench mark papers in Geology
10. Shartna, H. 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

GEL02C102 - BASICS OF GEOGRAPHIC INFORMATION SYSTEM

Course Outcomes:

- *The student will be able to explain GIS, its components, functions and platforms.*
- *The student will be able to describe about maps, map elements and types of projections.*
- *The student will be able to demonstrate usage of satellite and aerial imageries.*
- *The student will be able to explain data models of GIS and database management.*

Module 1

- GIS – definition and scope, Origin of GIS
- Components of GIS – hardware, software, people, methods, data;
- Functions – data input and output, visualization, editing, analysis, design;
- Desktop GIS, mobile GIS, web GIS; Limitations of GIS

Module 2

- Maps – to convey location and extent, characteristics
- Classification of maps – topographic maps, thematic maps, cadastral maps
- Elements of a map – scale, datum, coordinate systems
- Classification of projection – Cylindrical, Conical, Azimuthal; Map design

Module 3

- Sources of GIS data –Conventional analogue map sources – Topographical maps
- Thematic maps, Geologic maps & Existing digital map sources; Aerial photographs & satellite imageries
- Field data sources – Surveying & GPS
- Data models in GIS; Spatial data model – Raster & Vector; Attribute data model – hierarchical, network, relational

Module 4

- Data base management system; Data management in GIS;
- Data editing: Detecting and correcting errors
- Data reduction, Generalization, Transformation; Rubber Sheeting and edge matching

Module 5

- Downloading of toposheets
- Interpretation of toposheets
- Georeferencing of spatial data

References:

1. "Introduction to Geographic Information Systems" by Kang-Tsung Chang (McGraw-Hill Education, 2018)
2. "Geographic Information Systems and Science" by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind., (Wiley, 2015)
3. "Principles of Geographical Information Systems" by Peter A. Burrough and Rachael A. McDonnell., (Oxford University Press,1998)
4. "Elements of Photogrammetry with Applications in GIS" by Paul R. Wolf, Bon A. Dewitt, and Benjamin E. Wilkinson., (McGraw-Hill Education, 2014)
5. "Principles of Geographic Information Systems" by Rolf A. de By and Henk J. Scholten (ITC,2010)
6. "The GIS 20: Essential Skills" by Gina Clemmer., (ESRI Press, 2013)

SEMESTER-III

GEL03C201 - UNDERSTANDING SUBSURFACE WATER RESOURCES

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 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 impacts of groundwater extraction.*
- *The student will be able to describe the types of wells, various problems related to groundwater, and artificial recharge*

Module 1

- Hydrogeology – Definition, significance and scope
- Hydrological cycle – components and processes
- Vertical Distribution of groundwater

Module 2

- Occurrence of groundwater – aquifer, aquiclude, aquifuge and aquitard
- Classification of aquifers – confined and unconfined aquifer
- Water bearing properties of rocks

Module 3

- Groundwater quality – physical and chemical properties of water
- Water quality criteria for domestic, irrigation and industrial uses
- Saline water intrusion - control and prevention measures

Module 4

- Water table fluctuations – seasonal, secular and diurnal
- Water wells – types and classification
- Problems of over exploitation of groundwater

Module 5

- Groundwater problems related to foundation work, mining and tunnelling
- Artificial recharge of groundwater
- Rainwater harvesting

References:

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.

GEL03C202 - ADVANCED GEOINFORMATICS

Course Outcomes:

- *The student will be able to explain various types of remote sensing.*
- *The student will be able to demonstrate digital image processing techniques*
- *The student will be able to explain applications of remote sensing in various fields.*
- *The student will be able to demonstrate various advanced GIS analysis.*
- *The student will be able to describe the applications of GIS in the modern world*

Module 1

- Optical remote sensing – panchromatic, multispectral, hyperspectral
- Thermal remote sensing: principles and applications
- Microwave remote sensing

Module 2

- Introduction to digital image processing
- Preprocessing – Geometric and radiometric corrections Image registration, enhancement & filtering;
- Image classification: Supervised & Unsupervised

Module 3

- Applications of Remote Sensing; Landuse land cover mapping;
- Soil, Agriculture – crop monitoring, crop damage assessment, NDVI;
- Geology – structural mapping, lineament extraction, mineral exploration;
- Forestry, Environment, Hydrology – water quality monitoring; DEM
- Oceans – measurement of SST, oil spill detection

Module 4

- Topology and spatial relationships- adjacency, containment, connectivity;
- Attribute data entry, Database query; Geospatial measurement;
- Overlay operations; Network analysis; Surface analysis, Map layout

Module 5

- Applications of GIS
- GIS applications in Environment and Natural Resources Management; Street Network; Urban Planning, Disaster management, Land Information System, climate change analysis

References:

1. "Introduction to Geographic Information Systems" by Kang-Tsung Chang (McGraw-Hill, 2018)
2. "Remote Sensing and Image Interpretation" by Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman., (Wiley, 2015)
3. "Geographic Information Systems and Science" by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind., (Wiley, 2015)
4. "Elements of Photogrammetry with Applications in GIS" by Paul R. Wolf, Bon A. Dewitt, and Benjamin E. Wilkinson., (McGraw-Hill Education, 2014)
5. "Principles of Geographic Information Systems" by Rolf A. de By and Henk J. Scholten (ITC,2010)
6. "The GIS 20: Essential Skills" by Gina Clemmer., (ESRI Press, 2013)
7. "Remote Sensing and Image Interpretation" by Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman (Wiley, 2015)
8. "Fundamentals of Remote Sensing" by George Joseph., (Universities Press, 2005)
9. "Remote Sensing Digital Image Analysis" by John A. Richards., (Springer, 2013)
10. "Principles of Geographical Information Systems" by Peter A. Burrough and Rachael A. McDonnell., (Oxford University Press,1998)
11. "GNSS Applications and Methods" by Scott Gleason and Demoz Gebre-Egziabher., Artech House, 2009)