Savitribai Phule Pune University

Pune, Maharashtra India

Structure and Syllabus of Three Years B. Sc. Program in Geology with Multiple Entry and Exit Option

THREE-YEAR BACHELOR'S PROGRAMME IN SCIENCE

Subject: **GEOLOGY**

Under the Faculty of

Science and Technology

Effective from Academic Year 2026– 27 (T.Y.B.Sc.)

(As per NEP-2020)

Title of the Program: T. Y. B. Sc. Geology Syllabus.

Program Level: Third year of a 3-year B.Sc. Geology Degree Program

Syllabus to be implemented from the Academic Year 2026-27

Introduction

The third-year syllabus is designed to meet students' needs as they build their careers in Geology. Considering the changing career and opportunity scenario at local and global levels, and the emergence of natural calamities such as earthquakes, volcanic eruptions, landslides, floods, tsunamis, or droughts, the significance of geology has always remained at forefront amongst all other sciences. Further, the rapid depletion of natural resources including the energy sources, it has become imperative that geology, which encompasses the science of all these issues be taught effectively at the undergraduate levels. Further the skills and awareness related to the modern concepts of Plate Tectonics, Remote Sensing, and Geographical Information Systems (GIS), etc., is essential to Geology graduate students. Theoretical knowledge, supplemented by extensive laboratory expertise and field training, will help students avail themselves of all opportunities including entrepreneurship.

This revision and updating of the curriculum are essential components and continuous processes in the university system, and the NEP 2020 has given this opportunity with a better vision. The curriculum is reframed periodically to incorporate necessary reorientations, additions, and modifications introduced by the respective universities, so that it remains compatible with and in tune with the fast-paced developments in the subject. It should provide easy placement opportunities for students and good avenues for research activities. Introducing innovative concepts, providing a multidisciplinary profile in the concerned subject, and providing updated education to students at large should be the prime aim while revising/renewing the curriculum. The undergraduate curricula are designed to impart fundamental concepts of Geology from all possible aspects. In addition, field training is prioritized, and greater practical exposure will benefit the student community at large and produce more qualified geologists for the nation.

Objectives to be achieved

1. To help students build a progressive and successful career in Geology
2. To enrich students’ knowledge and train them in the pure geological sciences.

3. To provide an updated education.

4. To impart more field-oriented knowledge.

5. To inculcate a sense of scientific, social responsibilities, and environmental awareness.

6. To introduce the concepts of application and research in Geology.

7. Create a sense of preservation and conservation of natural resources.

8. To study the structural dynamics of the Earth.

9. To study Stratigraphy and Paleontology that encompasses the aspects of the age of the earth, chronological arrangement of rocks, and appearance and evolution of life through geologic time.

10. To study the changes that occurred in the history of the Earth and relate them to their field observations, in understanding the framework of the stratigraphy of India

11. To understand importance of water through the study of Hydrogeology, the concept of watershed management help them in development and management concepts.

12. Subject like Petroleum and Coal geology helps students about fuel resources of India

13. To study the processes involved in the formation of minerals and minerals of economic importance.

14. To study the dynamic nature of the Earth processes through oceanography and marine Geology and Climatology.

15. To study climatology and marine geology helps students in understanding and building the overall knowledge in Geology.

Faculty of the Program: Science

Credit Framework

Level	Qualification Title	Credit Requirement		Semester	Year
		Minimum	Maximum		
4.5	Undergraduate Certificate in Geology	40	44	2	1
5.0	Undergraduate Diploma in Geology	80	88	4	2
5.5	Bachelor of Science in Geology	120	132	6	3

Credit Framework for Undergraduate (UG) (2025-26) for GEOLOGY in the Faculty of Science and Technology (SPPU)

B. Sc. in Geology

Level/ Difficulty	Sem.	Course Type	Course Code	Course Title (Brief on contents/levels)	Theory/ Practical	Credit	Hrs
4.5/100	I	Subject 1, 2 or 3	GL-101-T	**Mineralogy and Crystallography**	Theory	2	30
			GL-102-P	**Practicals related to GL-101-T**	Practical	2	60
		Generic Elective (GE) / Open Elective (OE) - (select one from the basket)	OE-101-GL-P	**Minerals and Gems**	Practical	2	60
			OE-102-GL-T	**Introduction to Earth Science**	Theory	2	30
			OE-103-GL-T	**Introduction to Geohazards**	Theory	2	30
		Skill Enhancement Courses (SEC)	SEC-101-GL-T	**Earth System Science**	Theory	2	30
		Indian Knowledge System		**Generic**	Theory	2	30
		Ability Enhancement Course (AEC)	AEC 101	**English Language**	Theory	2	30
		Value Education Courses (VEC)	VEC-101-T	**Environmental Education I**	Theory	2	30
4.5/100	II	Subject	GL-151-T	**Petrology**	Theory	2	30
			GL-152-P	**Practicals related to GL-151-T**	Practical	2	60
		Generic Elective (GE) / Open Elective (OE) - (Any one from basket)	OE-151-GL-P	**Introduction to Rocks**	Practical	2	60
			OE-152-GL-T	**Study of Landforms**	Theory	2	30
		Skill Enhancement Courses (SEC)	SEC-151-GL-P	**Gemmology**	Practical	2	60
		Ability Enhancement Course (AEC)	AEC- 102	**English Language**	Theory	2	30
		Value Education Courses (VEC)	VEC-151-T	**Environmental Education II**	Theory	2	30
		Curricular Course (CC)		**Select any one from Basket**			

Exit Option: Award of UG Certificate in Major with 44 credits core NSQF course/internship OR continue with Major and Minor. (National Skill Qualification Framework)
Continue Option: Student will select one subject (Subject1, 2 or 3) as major and another as minor and third subject will be dropped.

5.0/200	**III**	**Major Core**	GL 201 T	**Introduction to Stratigraphy**	Theory	2	30
			GL 202 T	**Structural Geology**	Theory	2	30
			GL 203-P	**Practicals related to GL 201 T & 202 T**	Practical	2	60
		Vocational Skill Courses (VSC)	VSC 201 GL - T	**Hydrogeology**	Theory	2	30
		Field Project (FP)	FP 201 GL-P	**Mapping, Surveying, and Field Project**	Practical	2	60
		Minor	MN 201 GL-T	**Introduction to Structural Geology**	Theory	2	30
			MN 202 GL-P	**Practicals related to** MN 201 GL-T	Practical	2	60
		Generic Elective (GE) / Open Elective (OE) (Select one from basket)	OE-201-GL-P	**Gemmology**	Practical	2	60
			OE-202-GL-T	**Introduction to Natural Resources**	Theory	2	30
		IKS (Major Subject Specific)	IKS 201 GL T	**Ancient Knowledge System in Geosciences**	Theory	2	30
		AEC (Ability Enhancement Course)	AEC 201	**Modern Indian Languages**	Practical	2	30
		Curricular Course (CC)	CC	**NCC/NSS/Sports/Cultural/Yoga Study**	T/P	2	30
5/200	**IV**	**Major Core**	GL 251 T	**Advance Petrology**	Theory	2	30
			GL 252 T	**Geotectonics**	Theory	2	30
			GL 253-P	**Practicals related to GL 251 T and GL 252 T**	Practical	2	60
		VSC	VSC 251 GL - T	**Optical Mineralogy**	Theory	2	30
		FP	CEP	**CEP**	T/P	2	30
		Minor Courses	MN 251 GL-T	**Dynamics of the Earth**	Theory	2	30
			MN 252 GL-P	**Practicals related to** MN 251 GL-T	Practical	2	60
		Skill Enhancement Courses (SEC)	SEC 251 GL - T	**Geophysical Prospecting**	Theory	2	30
		Curricular Course (CC)	CC	**NCC/NSS/Sports/Cultural/Yoga Study**			
		Ability Enhancement Program (AEC)	AEC	**Languages**	Theory	2	30
		Generic Elective (GE) / Open Elective (OE) - (Select one from basket)	OE-251-GL-P	**Introduction to GIS**	Practical	2	60
			OE-252-GL-P	**Water Resource Management**	Theory		30
Exit Option: Award of UG diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/Internship OR continue with Major and Minor							

5.5/300	**V**	**Major Core**	GL 301 T	**Geology of India I**	Theory	2	30
			GL 302 T	**Engineering Geology**	Theory	2	30
			GL 303 T	**Palaeontology**	Theory	2	30
			GL 304 T	**Remote Sensing in Geosciences**	Theory	2	30
			GL 305 P	**Practicals related to GL 301 T, GL 302 T, GL 303 T and GL 304 T**	Practical	4	120
		Major Elective Courses	GL 311 T ME	**Micropalaeontology**	Theory (Select One from Basket)	2	30
			GL 312 T ME	**Oceanography and Marine Geology**		2	30
			GL 313 T ME	**Geomorphology**		2	30
			GL 314 T ME	**Quaternary Geology**		2	30
			GL 315 P ME	**Elective Practical related Major Elective**	Practical	2	60
		Vocational Skill Courses (VSC)	VSC 301 GL T	**Natural Disaster Management**	T/P	2	30
		FP/CEP	FP 301 GL P	**Field Project and Scientific Report Writing**	T/P	2	30
		Minor	MN 301GL T	**Petroleum Geology**	T	2	30
5.5/300	**VI**	**Major Core**	GL 351 T	**Geology of India II**	Theory	2	30
			GL 352 T	**Economic Geology and Mineral Deposits**	Theory	2	30
			GL 353 T	**Climatology**	Theory	2	30
			GL 354 T	**Petroleum and Coal Geology**	Theory	2	30
			GL 355 P	**Practicals related to GL 351 T, GL 352 T, GL 353 T and GL 354 T**	Practical	4	120
		Major Elective Courses	GL 361 T ME	**Geotechnical Studies**	Theory (Select any One from Basket)	2	30
			GL 362 T ME	**Watershed Management**		2	30
			GL 363 T ME	**Analytical Methods in Geology**		2	30
			GL 364 T ME	**Environmental Geology and Sustainability**		2	30
			GL 365 P ME	**Elective Practical related to GL 361 to 364**	Practical	2	60
		VSC	VSC 351 GL T	**GIS and Geoinformatics**	T/P	2	30
		OJT	GL 371 OJT	**ON Job Training**		4	
Exit Option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor							
6.0/400	**VII**	**Major Core**	GL 401 MJ	**Theory 1, Theory 2, Theory 3**		6	90
			GL 401 MJP	**Practicals related to theory**		4	120
		Major Elective Courses - (0C)	GL 411 ME	**Theory**		2	
			GL 412 P	**Practical**		2	
		FP/OJT/CEP/RP	GL 421 FP	**Research Project**		4	
		Research Methodology	GL 431 RM	**Research Methodology**		4	
		Major Core	GL 451 MJ	**Theory1 , Theory 2, Theory 3**		6	90

6.0/400	**VIII**		GL 452 MJP	**Practical**		4	120
		Major Elective Courses - (0C)		**Theory**		2	
				Practical		2	
		FP/OJT/CEP/RP	GL 461	**Research Project**		8	

Four Year UG Honours Degree in Major and Minor with 176 credits

Notes: OE to be compulsorily chosen from faculty other than that of Major

Abbreviations

OE: Open Elective
AEC: Ability Enhancement Course
VEC: value Education Courses
CC: Co-Curricular Courses
CEP: Community Engagement Project
IKS: Indian Knowledge System
OJT: On Job Training
FP: Field Project
VSC: Vocational Skill Courses

Semester V

GL 301 T- Geology of India I

Title of the Course and Course Code	**Geology of India I GL 301 T**	**Credits:2**
Course Learning Outcomes (CLOs). On completion of the course, the students will be able to:		
CLO 1	Explain Precambrian stratigraphy and craton evolution.	
CLO 2	To acquire the knowledge of the concepts in Stratigraphy and correlation	
CLO 3	To study the mobile belts of India	
CLO 4	Stratigraphic study of the Proterozoic basin of India.	
CLO 5	To understand the Phanerozoic study of India	
CLO 6	To study Extra-Peninsular India	
CLO 7	To study the Geology and Stratigraphy of Maharashtra	

Credit	**Course Contents**	**No of Lectures**
I	**Precambrian rocks of Peninsular India** **A) Brief account of distribution, Geographical location, classification, lithological succession, structure, and economic importance, with a broad range of stratigraphic correlation.** a) Dharwar Craton b) Singhbhum Craton c) Bhandara-Bastar Craton d) Aravalli Craton e) Bundelkhand Craton	**15**
II	**Mobile Belts and Proterozoic Basins of India** A) The Eastern Ghat mobile belt: Description and distribution of the Chalk Hills, Sitampundi Complex, Khondalites and Kodurites. The Satpura mobile belt/ CITZ (Central Indian Tectonic Zone): Constituents and extent, N-S tabular cross-section of CITZ, lithostratigraphy of the Sausar belt/Group **B) The Archaean – Proterozoic boundary** **C) Brief account of distribution, geographical location, classification, lithological succession, structure, and economic importance, with a broad range of stratigraphic correlation.** a) The Delhi Supergroup b) The Vindhyan Supergroup c) The Cuddapah Supergroup d) The Kaladgi Supergroup	**15**

	Reference Books:
	1. G.G. Deshpande (2002): Geological of Maharashtra- Geological Society of India – Special Publication. 2. K.S. Valdiya (2010), The Making of India – Geodynamic evolution. Springer 3. Fundamentals of historical geology and Stratigraphy of India, Ravindra Kumar 4. Geology of India Volume I & II- Vaidyanathan and Ramakrishnan 5.Naqvi, S.M., 2005. Geological Evolution of the Indian Plate (From Haedean to Holocene -4Ga to 4Ka)

	GL 302 T - Engineering Geology	(Credits 2)
	Major Theory	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
CLO 1: Explain the scope and importance of Engineering Geology in civil engineering and environmental projects. CLO 2: Describe the physical and mechanical properties of rocks relevant to construction purposes. CLO 3: Identify suitable rocks and aggregates for different engineering works. CLO 4: Interpret basic geological data such as bore logs, discontinuities, and site observations. CLO 5: Discuss geological considerations involved in tunnels, dams, reservoirs, and bridge foundations. CLO 6: Apply basic geological principles in evaluating the suitability of sites for infrastructure development.

Credit	Content	No of Lectures
I	**Engineering Properties of Earth Materials**	
	A. Introduction to Engineering Geology Definition, scope, and objectives Role of geology in civil engineering Importance in environmental and infrastructure projects Relationship between geology and construction **B. Rocks as Construction Materials** • Building stones and foundation rocks • Desirable properties of construction materials • Durability of rocks • Effect of weathering on construction materials Basic classification of rocks based on engineering use	8
	C. Engineering Properties of Rocks • Physical properties: Specific gravity, porosity, water absorption • Mechanical properties: Compressive strength and tensile strength (concept only) • Factors affecting the strength of rocks • Influence of joints, bedding planes, and fractures Importance of clay minerals in engineering **D. Aggregates in Construction** • Types of aggregates • Sources of aggregates • Physical properties Suitability for construction	7

II	**Site Investigation and Geological Aspects of Engineering Structures**	
	E. Site Investigation Methods • Purpose of site investigation • Surface and subsurface investigation • Boreholes and simple logging • Basic concept of Rock Quality Designation (RQD) Measurement of discontinuities (conceptual understanding) **F. Geological Aspects of Tunnelling** • Types of tunnels • Geological factors affecting tunnel construction • Tunnelling in bedded and folded rocks • Effect of faults and groundwater • General discussion of a major Indian tunnel (conceptual case example) Tunnels in the Deccan Traps. Names and locations of at least six very important tunnels in India, Case study: Jawahar Tunnel	8
	G. Geological Considerations in Dams and Reservoirs • Types of dams • Geological requirements for dam sites • Foundation problems • Seepage and leakage • Basic concept of reservoir-induced seismicity Location of all the important dams and hydroelectric projects in India. Case study: Sardar Sarovar Dam **H. Geological Aspects of Bridges** • Site selection criteria • Foundation problems in river and coastal regions • Scour and sedimentation • Geological challenges in major bridge construction Names and locations of at least six very important bridges in India. Case study: Mumbai Sea-Link	7

	Reference Books:
	1. **Bell, F. G. (2007).** *Engineering Geology*. 2nd Edition. Butterworth–Heinemann (Elsevier), Oxford, UK. 2. Blyth, F.G.H. and M. H. de Freitas (1984). Geology for Engineers, Butterworth - Heinemann Title 3. Chenna Keshvallu (2018). Textbook of Engineering Geology, Laxmi Publications. 4. **Garg, S. K. (2009).** *Physical and Engineering Geology.* Khanna Publishers, Delhi.

5. Gokhale, K.V.G. (2006). Principles of engineering geology, BS publications.
6. **Krynine, D. P., & Judd, W. R. (2002).** *Principles of Engineering Geology and Geotechnics.* CBS Publishers & Distributors, New Delhi. *(Indian reprint edition; original edition published earlier by McGraw-Hill.)*
7. Krynine, D.P and Judd, W.R (2005). Principles of Engineering Geology and Geotechniques, CBS Publishers & Distributors
8. Ries, H. and T. L. Watson, (1949). Elements of Engineering Geology, New York, John Wiley & Sons, Inc.
9. **Singh, Parbin (2018).** *Engineering and General Geology*. 8th Edition. S. K. Kataria & Sons, New Delhi.
10. Tony Waltham (2009). Foundations of Engineering Geology, Taylor and Francis.

	GL 303 T – Palaeontology	(Credits 2)
	Major Theory	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:	
CO1	Describe various processes involved in the formation of fossils.
CO2	Classify various types of fossils on the basis of their morphological features.
CO3	Examine fossils in hand specimens or under a microscope.
CO4	Explain the significance of fossils in the interpretation of depositional environments.
CO5	Compare fossils belonging to various phyla.
CO6	Prepare a report on fossil samples collected during the study tour.

Credit	Content	No of Lectures
I	**Introduction to Palaeontology and Invertebrate Palaeontology** Paleontology: Definition, branches, importance, and scope. Fossils: Definition, conditions and modes of preservation of fossils, Techniques used in collection (Spot and channel), preservation and illustration of mega fossils, Uses and Importance of fossils, Mass extinction, causes and evidence Systematic position, morphology of hard parts, geological and geographical distribution of the following: **Phylum Mollusca:** Class Lamellibranchia or Bivalvia: Morphology of hard parts of the shell, ornamentation, and types of hinge lines, Class Gastropoda: Morphology of hard parts of the shell and forms of the gastropod shell, Class Cephalopoda: Morphology of hard parts of Nautilus, Ammonoids, Belemnites, and types of suture lines. Comparison between Nautilus and Ammonoids. Evolutionary Trends in Ammonoids	7
	Systematic position, morphology of hard parts, geological and geographical distribution of the following: **Phylum Brachiopoda** Morphology of hard parts of Class Articulata and Inarticulata. Types of brachial skeleton, Comparison between Lamellibranchs and Brachiopods. **Phylum Echinodermata** Class Echinoidea: Morphology of hard parts of Regularia. Variation in the apical disc in echinoids. **Phylum Arthropoda** Class Trilobita – Morphology of hard parts of Trilobites and evolutionary trends. **Phylum Coelenterata** Class Anthozoa- Madreporaria, polyp, medusa, types of septa. Origin and evolution of life over geological time. Concepts of organic evolution. (Definition, Evidence of evolution, Macro & Micro evolution, Darwinism, Lamarckism & Mutation)	8

II	**Micropalaeontology** Introduction to Micropalaeontology, Definition, different types of microfossils, their size range and composition. Different branches of Micropalaeontology, uses of microfossils. Field and Laboratory Techniques: Field techniques for collection of microfossils (sampling methods), Laboratory techniques for separation- Mechanical and chemicals methods, Recovery of microfossils from shale and limestone. Separation of microfossils from coal (maceration), Preservation and Illustration.	10
	Ichnology Ichnofossils its classification, significance	5

	References:
	1.Woods, H., 1958, Text Book of Palaeontology (Invertebrate), Cambridge University Press, UK. 2.Clarkston E.N.K., 1998, Invertebrate Palaeontology and Evolution, 4th Edition, Wiley – Blackwell, 468p. 3.Brasier, M.D., 2011, Microfossils, Chapman & Hall, 193p. 4.Remer: Vertebrate Palaeontology.

	GL 304 T – Remote Sensing in Geosciences	(Credits 2)
	Major Theory	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:

CO1 Identify various photo recognition elements from remotely sensed data.
CO2 Discuss various geomorphic features, lithologies and structural elements from remotely sensed data.
CO3 Apply remote sensing principles and photo recognition elements to identify various features.
CO4 Analyze remotely sensed data, draw conclusions regarding the geological history of an area.
CO5 Compare between different types of remotely sensed data and evaluate its utility.
CO6 Assemble remote sensing and geomorphological data and prepare a report.

Credit	Content	No of Lectures
I	**A) Definition, Types of Remote sensing Systems** Elements of passive Remote sensing system (data acquisition & data analysis) **B) Energy source and radiation principles** (EM wave, Wave theory, EM spectrum, particle theory, Stefan-Boltzman's law, Emissivity, Black, white & grey bodies) **C) Energy interactions in the atmosphere** (Scattering, absorption, atmospheric windows & related sensing systems); Energy interactions with the earth (principles of the Conservation of energy, specular & diffused reflectors), Spectral reflectance of vegetation, soil & water; Data acquisition & interpretation.	7
	D) Aerial Photography a. Classification of aerial photographs on the basis of Camera axis b. Film and filter combination, lens system, types of cameras, high and low sun angle photography, digital cameras **E) Planning of Aerial photography** Geometric characteristics of Aerial photos, marginal information on Aerial photos, Scale of Aerial photos, ground and photographic resolution of Aerial photos, Vertical exaggeration and relief displacement in Aerial photos. c. Mirror and pocket stereoscopes.	8
II	**Interpretation and application of Remote sensing data** A) **Photo Recognition Elements**: Tone, texture, pattern, shape, size, site, shadow, associations. Basic drainage patterns and their geological significance. Advantages and limitations of Aerial photos. B) **Photo-geological interpretations** Photo characters of Sedimentary, igneous and metamorphic rocks. Interpretation of geologic structures	8
	C) **Introduction to Satellites**, Sensors & their applications: Brief history, Types of Satellites (Orbital Characteristics, Sensors and applications with reference to latest IRS & LANDSAT: LANDSAT 7 and 8, IRS satellites (Oceansat, Cartosat, Resourcesat, SARAL)	7

	D) Scanners: Hyperspectral Scanners, Active Remote Sensing Systems RADAR and LIDAR (Principles & applications) **E) Image characteristics & Spectral** responses of various features, Applications of Remote sensing: In studying the natural resources like minerals, ground water, soil, forests & in geo-technical investigations.	

	Reference Books:
	1. Lillesand T. M., Kiefer R. W. and Chipman J. (2015) Remote Sensing and Image Interpretation, Wiley 2. Drury S. A. (1990) A Guide to Remote Sensing - Interpreting Images of Earth, Oxford 3. Pandey S. N. (2001) Principles and Applications of Photogeology, New Age International 4. John R. Jenson (2003) An earth resource perspective 5. Miller Victor C. Miller Calvin F. (1961): 6. Photogeology (International Series in the Earth Sciences): 7. Paine, D.P (1981) management: Aerial photography and image interpretation for resource 8. Gary L. Prost: Remote Sensing for Geologists- A Guide to image interpretation 9. Reddy A. (2012): Introduction to Remote Sensing and GIS 10. Ramasamy, SM. (1999) Trends in Geological Remote Sensing

Paper Code: GL 305 P	Credits 4
Practicals related to GL 301T, GL302 T, GL 303 T and GL 304 T	

Practicals related to GL 301 T Geology of India I	Credit 1

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
CLO 1 Understand Structural features in the field
CLO 2 Gain knowledge about geometry of rock structure
CLO 3 Analyze graphical representation of rock Structures of subsurface areas
CLO 4 Understand the stratigraphic correlation

Topics	No. of Practicals
Precambrian Stratigraphy of India **Preparation of maps showing geographical distribution of the following stratigraphic units of India:** **a.** Dharwar Supergroup, b. Orissa – Singhbhum belt, c. Aravalli Supergroup d. Cuddapah Supergroup, e. Vindhyan Supergroup	**3**
Study of typical hand specimens of rocks from different lithological units of Precambrians of India: Dharwar Craton, Bastar Craton, Aravalli Craton, Orissa-Singhbhum Craton, Bundelkhand Craton, Eastern Ghat mobile belt, Vindhyan, Cuddapah, Kaladgi Basin	**2**
Interpretation of geological map of India	**1**
Total No. of Practicals	**6**

Practicals related to GL 302 T Engineering Geology	**Credit 1**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
• To develop applied understanding of engineering geological principles. • To interpret geological data for infrastructure development. • To evaluate suitability of earth materials for construction. • To build analytical and decision-making skills in site evaluation.

	Content	**No of Practicals**
	1. Preparation of Geological Sections and Interpretation for Tunnel, Dam and Bridge Sites. • Drawing geological cross-sections along given directions. • Interpretation of lithology, dip, faults and weak zones. • Identification of joints, spacing and orientation. • Application: Recommendation of suitable alignment. (May include Geological Aspects of Tunnelling: Case Study Based - Geological problems in tunneling, Support measures). (May include Geological Study of Dam Sites: Case Study Based - Geological requirements for dam foundation, Seepage and reservoir considerations.) (May include Geological Aspects of Bridge Foundations: Case Study Based - Site selection and foundation problems, Scour and sedimentation issues.)	01
	2. Study of Physical and Engineering Properties of Aggregates and Building Stones. • Megascopic study and identification. Evaluation of durability and suitability for construction.	01
	3. Determination and Interpretation of Engineering Properties of Rocks. • Specific gravity, porosity, water absorption (numerical problems). Application in foundation suitability assessment.	01
	4. Study and Interpretation of Bore Log Data. • Lithological interpretation. Identification of groundwater table and foundation conditions.	01
	5. Calculation and Classification of Rock Quality Designation (RQD). • Core data analysis. Rock mass quality classification and engineering implication.	01
	6. Field Visit Component (Industrial/Construction Site Visit)	1

	Objective: To provide field exposure to real-life engineering geological conditions. **Suggested Visits:** • Dam site / Irrigation project • Tunnel construction site • Bridge construction site • Quarry or aggregate production unit • Geotechnical investigation laboratory **Field Work Activities:** • Observation of lithology and structural features. • Identification of foundation conditions. • Interaction with engineers/technical staff. Submission of Field Visit Report.	

Practicals related to GL 303 T Palaeontology	**Credit 1**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
• Identify different mega fossils on the basis of morphological characters • Classify various mega fossils on the basis of morphology

	Content	**No of Practicals**
	Palaeontology Study of specimens from Phylum Mollusca: Class Lamellibranchia, Study of specimens from Class Gastropoda, Class Cephalopoda Study of specimens from Phylum Brachiopoda, Phylum Echinodermata Study of specimensPhylum Arthropoda, Phylum Coelenterata	**2** **1** **1** **2**

Practicals related to GL 304 T Remote Sensing in Geosciences	**Credit: 1**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:	
CLO1	Compute the scale of aerial photographs and base flow contribution from given stream flow data
CLO2	Examine different remote sensing data using photo recognition elements and calculate specific capacity of wells from pumping test data
CLO3	Analyze lineament orientations from given remote sensing data and groundwater quality using various methods

	Content	**No of Practicals**
	Geomorphic, lithological and structural interpretations from aerial photographs	1
	Digital Elevation Models (DEMs) and Geomorphological Mapping	1
	Structural Geological Mapping and Lineament Analysis: Map structural features on a regional scale.	1
	Problems related to scale of aerial photographs and relief displacement	1
	Interpretation of Satellite Images Structural Geological Mapping and Lineament Analysis: Map structural features such as faults, folds, and lineaments that dictate regional tectonics.	2
	Total	**6**

	GL 311 T ME - Micropalaeontology	(Credits 2)
	Major Elective -Theory	**Hours :30**

Course Outcomes (Cos) **On completion of the course, the students will be able to:**	
CO1	Describe various processes involved in the formation of fossils.
CO2	Classify various types of microfossils on the basis of their morphological features.
CO3	Examine microfossils under microscope.
CO4	Explain the significance of microfossils in the interpretation of depositional environments.
CO5	Compare microfossils belonging to various phyla.
CO6	Prepare a report on microfossils found in rock samples collected during the study tour.

Credit	Contents	Number of Hours
I	**Micropalaeontology** Introduction to Micropalaeontology, Definition, different types of microfossils, their size range, and composition Different branches of Micropalaeontology, uses of microfossils	**7**
	Field and Laboratory Techniques: Field techniques for collection of microfossils (sampling methods), Laboratory techniques for separation- Mechanical and chemicals methods, Recovery of microfossils from shale and limestone. Separation of microfossils from coal (maceration), Preservation and Illustration	**8**
II	Study of the following microfossils: (with respect to their morphology, environmental and paleo-ecological significance and importance) Foraminifers, Ostracods, Diatoms and Radiolarian.	**8**
	Palaeobotany Introduction to Palaeobotany, Classification of Plants, preservation of parts of plants, Study of Pollens and Spores	**7**

	Reference Books:
	1. Woods, H., 1958, Text Book of Palaeontology (Invertebrate), Cambridge University Press, UK. 2. Clarkston E.N.K., 1998, Invertebrate Palaeontology and Evolution, 4th Edition, Wiley – Blackwell, 468p. 3. Brasier, M.D., 2011, Microfossils, Chapman & Hall, 193p. 4. Remer: Vertebrate Palaeontology.

	GL 312 T ME - Oceanography and Marine Geology	(Credits 2)
	Major Elective	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:	
I.	Evaluate the tectonic life cycles and structural features of the seafloor.
II.	Students must determine the source, transport mechanics, and depositional pathways of ocean floor materials.
III.	Students will be able to explain how seawater dynamics drive geological and environmental changes.
IV.	Student will be able to evaluate the evolution of ocean basins, track coastal-to-deep-sea sedimentary processes.

Credit	Content	No of Lectures
I	**Physical oceanography** Introduction, Parameters: Pressure, temperature, density. Ocean Salinity (Definition and variation) Ocean currents (Introduction, origin and components) El-Nino-La Nino effect	8
	Oceanic Processes and Coastal Regulatory Zones Sea level changes: Introduction and process affecting sea level The Coast: Beach (definition, sediment movements, erosional and depositional features) Coastal Regulatory Zones	7
II	**Study of Ocean floor** Physiographic divisions of oceans (the Continental Shelf, the Continental Slope, the Deep Sea Plain & the Oceanic Deeps) Ocean floor rocks - Ultramafic rocks, Gabbroic rocks & Basalts Marine sediments. Origin, structure, and evolution of the Indian Ocean shelf and margins (estuaries, deltas, tidal flats)	8
	Ocean floor sediments Applications of Geophysical Techniques for Exploration of the Sea Floor Marine Sediments: Introduction, Sources, Composition and distribution. Exclusive economic zones (EEZ)	7

	References:
	1) Webb P. (2023) Introduction to Oceanography, Rebus Community. 2) Savindra Singh (2015) Oceanography, Pravalika Publications. 3) Garrison, T. (2016). Essentials of oceanography (7th ed.). Cengage Learning. 4) Woodroffe, C.D. (2013) Coast: Form, process and evolution, Cambridge University Press. 5) Talley, L. D., Pickard, G. L., Emery, W. J., & Swift, J. H. (2011). Descriptive physical oceanography: An introduction (6th ed.). Academic Press.

	6) Steele, J. H., Thorpe, S. A., & Turekian, K. K. (Eds.). (2010). Elements of physical oceanography. Academic Press. 7) Dronkers J. (2005) Dynamics of coastal systems, World Scientific. 8) Stewart R. H. (2000) Introduction to Physical Oceanography. 9) Kenneth, J. (1982) Marine Geology and Geophysics.

	GL 313 T ME - Geomorphology	(Credits 2)
	Major Elective	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
I. Decode landforms to interpret landscape evolution, II. Quantify modern earth surface processes, and evaluate geohazards. III. Analyse the energetic and mechanical drivers that reshape the Earth's surface. IV. Characterize Morphoclimatic & Process-Specific Landscapes, V. Synthesis Tectonic Geomorphology & Landscape Evolution VI. Develop the skills on Terrain Analysis

Credit	Content	No of Lectures
I	• **Introduction & Concepts:** Definitions, nature, and scope of geomorphology; basic concepts (e.g., Uniformitarianism, Davisian cycles); hierarchy of spatial and temporal scales. • **Geomorphology and Tectonics:** Earth's internal structure (physical/chemical properties), seismic waves, Continental Drift, Plate Tectonics, and associated landforms. • **Weathering & Soils:** Physical and chemical weathering processes, agents of weathering, soil formation, soil profile development, and pedogenic processes.	7
	• **Geomorphic Agents & Landforms:** • **Fluvial Processes:** River action, drainage patterns, erosional/depositional landforms. • **Aeolian Processes:** Wind action, landforms in arid regions. • **Glacial/Periglacial Processes:** Landforms formed by ice. • **Coastal Processes:** Waves, currents, sea-level changes (eustasy), coastline features.	8
II	• **Applied Geomorphology:** • **Tectonics:** Geomorphic indicators of tectonic activity, neotectonic interpretation (drainage patterns, alluvial fans, mountain fronts). • **Applied:** Geomorphology in mineral prospecting, groundwater exploration, and hydrocarbon exploration. • **Engineering:** Landform evaluation for engineering structures (dams, tunnels, bridges) and hazard management (landslides, floods).	9
	• **Indian Geomorphology:** • Physiographic divisions of India. • Evolution of the Himalayas and the Gangetic Plains.	6

	Reference Books:
	1. Kale V. S. and Gupta A. (2001) Introduction to geomorphology, Orient Longman 2. Thornbury W. D. (1954), Principles of G 3. *Principles of Geomorphology* by W.D. Thornbury. 4. *Geomorphology* by Savindra Singh. 5. *Introduction to Geomorphology* by Vishwas S. Kale & Avijit Gupta. 6. *Earth Surface Processes, Landforms and Sediment Deposits* by John Bridge and Robert Demicco

	GL 314 T ME - Quaternary Geology	(Credits 2)
	Minor Elective	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:

CLO 1: Understand the scope and significance of Quaternary geology and its place in the geological time scale.

CLO 2: Explain major climatic changes and glacial–interglacial cycles that occurred during the Quaternary Period.

CLO 3: Identify important Quaternary landforms and sediments formed by glacial, fluvial, and aeolian processes.

CLO 4: Describe methods used for reconstructing past climates and dating Quaternary deposits.

CLO 5: Recognize the relationship between Quaternary environmental changes and human evolution with reference to Indian examples.

Credit	Content	No of Lectures
I	**Introduction to Quaternary Geology and Glacial Processes** **A. Introduction to Quaternary Geology** • Definition and scope of Quaternary Geology • Geological time scale with emphasis on the Quaternary Period • Subdivisions of the Quaternary: ➢ Pleistocene Epoch ➢ Holocene Epoch • Major climatic fluctuations during the Quaternary • Milankovitch cycles and their role in glacial–interglacial cycles • Significance of Quaternary studies in understanding present-day climate change Indian Examples: ➢ Himalayan glacial history Quaternary sediments of the Indo-Gangetic plains	7
	B. Glacial and Periglacial Processes • Nature and types of glaciers • Glacial erosion and depositional landforms • Major glacial deposits: till, moraines, outwash deposits • Periglacial processes and landforms • Evidence of past glaciations Indian Examples: ➢ Gangotri and Siachen glaciers ➢ Glacial landforms in the Himalayas	8

	Ladakh periglacial environment	
II	**Quaternary Sedimentation, Sea-Level Changes and Human Evolution** A. Quaternary Sediments and Sea Level Changes • Characteristics of Quaternary sediments • Types of surficial deposits: ➢ Alluvium ➢ Loess ➢ Aeolian deposits ➢ Lacustrine deposits • River terraces and their significance • Quaternary sea-level fluctuations and coastal geomorphology **Indian Examples:** ➢ Indo-Gangetic alluvium ➢ Thar Desert aeolian deposits Marine terraces of the western coast (Konkan and Gujarat)	7
	B. Quaternary Climate, Dating Methods and Human Evolution • Reconstruction of Quaternary climate • Methods of Quaternary dating: ➢ Radiocarbon dating ➢ Dendrochronology ➢ Lichenometry • Quaternary environmental changes and their impact on landscapes • Evolution of humans during the Quaternary • Extinction of megafauna **Indian Examples:** ➢ Narmada Valley Quaternary deposits and hominid fossils ➢ Thar Desert palaeoclimate studies Quaternary coastal deposits of India	8

Reference Books:

1. Bowen, D. Q. (1988). *Quaternary Geology: A Stratigraphic Framework for Multidisciplinary Work*. Pergamon Press, Oxford.
2. Das, B. C., Ghosh, S., & Islam, A. (2018). *Quaternary Geomorphology in India: Case Studies from the Lower Ganga Basin*. Springer, Cham.
3. Goudie, A. (2002). *The Quaternary Period: Environmental Change*. Oxford University Press, Oxford.
4. Lowe, J. J., & Walker, M. J. C. (2015). *Reconstructing Quaternary Environments*. Routledge, London.
5. Murty, C. V. S. (2009). *Quaternary Geology: Indian Perspective*. Geological Society of India, Bangalore.
6. Rajaguru, S. N., Kale, V. S., & Badam, G. L. (1995). *Quaternary Environments and Geoarchaeology of India*. Deccan College Postgraduate and Research Institute, Pune.
7. Walker, M. (2005). *Quaternary Dating Methods*. John Wiley & Sons, Chichester.
8. Benn, D. I., & Evans, D. J. A. (2010). *Glaciers and Glaciation*. Routledge, London.
9. Bradley, R. S. (2015). *Paleoclimatology: Reconstructing Climates of the Quaternary*. Academic Press, London.
10. Emiliani, C. (1992). *Planet Earth: Cosmology, Geology and the Evolution of Life and Environment*. Cambridge University Press, Cambridge.
11. Roberts, N. (2014). *The Holocene: An Environmental History*. Wiley-Blackwell, Oxford.
12. Ruddiman, W. F. (2008). *Earth's Climate: Past and Future*. W. H. Freeman & Company, New York.
13. Smart, P. L., & Frances, P. D. (1991). *Quaternary Environments*. Longman Scientific & Technical, London.
14. Williams, M. A. J., Dunkerley, D. L., De Deckker, P., Kershaw, A. P., & Chappell, J. (1998). *Quaternary Environments*. Oxford University Press, Oxford.

Paper Code: GL 315 P ME	Credit: 2
Practical related to Major Elective	

Practicals related to Micropalaeontology	

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
CLO1 Understand different laboratory techniques to handle the samples CLO2 Describe different microfossils on the basis of their morphological features. CLO3 Classify various types of microfossils based on their morphological features. CLO4 Examine the microfossils and correlate different stratigraphic sections

	Content	**No of Practicals**
	Study of different laboratory techniques Microfossil Sample Processing & Picking Students learn to process raw sedimentary rocks (e.g., shales, marls) using physical and chemical methods (disaggregation, wet-sieving, heavy liquid separation).	**2**
	Morphological Analysis of Calcareous Foraminifera Examine benthic and planktonic foraminifera under a binocular stereo microscope.	**2**
	Ontogeny & Carapace Morphology in Ostracods Identify and describe ostracod carapaces, focusing on hinge structures, valve symmetry, and ornamental features	**2**
	Biostratigraphy & Graphic Correlation Aanalyse assemblages of index microfossils from stratigraphic sections	**2**
	Paleoenvironmental Interpretation using Microfossil Proxies Students analyse synthetic microfossil assemblages to reconstruct past environments	**2**
	Study of microfossils Pollens/ spores	**2**
	Total	**12**

Practicals related to Oceanography and Marine Geology	

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
CLO1: Understand bathymetric cross sections and hypsographic curves CLO2: Understand global surface and deep-water currents CLO3: Understand Global pressure belts CLO4: Understand relations with microfossils and changes in marine environments

	Content	**No of Practicals**
	Bathymetry and Seafloor Morphological Profiling Preparing of bathymetric cross-sections using Hydrographic sheets.	**2**
	Assigning different kinds of marine sediments to different bathymetric settings.	**2**
	Study of important global surface and deep-water currents, with special emphasis on the 'Conveyor Belt'.	**2**
	Study of Distribution of Global Pressure belts.	**2**
	Marine Micropaleontology and Paleo-oceanography Utilize microfossils to interpret past ocean climates and environmental changes.	**2**
	Marine Sediment Analysis and Classification Identify, classify, and describe unconsolidated marine sediments.	**2**
	Mud & Sand Component Analysis Using stereoscopic microscopes, students examine and classify bulk sediment samples into terrigenous, biogenous, hydrogenous, and cosmogenous origins.	**2**
	Total	**12**

Practicals related Geomorphology	

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
CLO1: Understand Drainage basins and calculate morphometric parameters CLO2: Understand different landforms and construct superimposed profiles CLO3: Tracing geomorphic features and identification of coastal landforms

	Content	**No of Practicals**
	Drainage Basin Morphometry Analysis Calculate basin morphometric parameters from topographic maps to understand runoff, infiltration, and tectonic uplift.	**1**
	Geological & Topographical Map Intersecting Interpret contour patterns to identify landforms (valleys, cuestas, mesas) and construct cross-sections to visualize subsurface structures.	**1**
	Stereographic Analysis of Mass Wasting Plot structural and planar discontinuities (foliations, joints, bedding planes) using a stereonet to determine potential failure directions.	**2**
	Remote Sensing & DEM Landform Tracing Tracing geomorphic features like (e.g., Google Earth, Landsat) and Digital Elevation Models (DEMs) using satellite imagery. Identification of fault scarps, alluvial fans, braided river channels, and coastal landforms.	**2**
	Sediment Grain-Size & Sphericity Analysis Conduct sieve analyses and clast-shape analysis in the laboratory to understand the dynamics of sediment transport	**2**
	Geomorphic Field Profiling Execute field-based data collection using a clinometer, measuring tape, and ranging rods to map local topography.	**2**
	Geohazard & Risk Mapping Overlay geological, topographical, and hydrological data to map terrain vulnerability to natural processes. Floodplain mapping, identification of fault lines, and mass-movement inventory mapping	**2**
	Total	**12**

Practicals related to Quaternary Geology	

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:

CLO1: Identify and describe common Quaternary sediments such as alluvium, aeolian sand, and lacustrine deposits.
CLO2: Recognize major glacial, fluvial, aeolian, and coastal landforms through maps, photographs, and satellite images.
CLO3: Interpret geomorphic features such as river terraces and coastal landforms using topographic maps and remote sensing images.
CLO4: Understand the basic principles of Quaternary dating methods and palaeo-climate indicators.
CLO5: Observe and record Quaternary deposits and landforms during field visits

	Content	**No of Practicals**
	1. Basin evolution and paleo-monsoons. Stratigraphic Logging of Fluvial and Alluvial Sections	**2**
	2. Geomorphic Mapping and Morphometric Analysis Using topographical maps (from the Survey of India) or digital elevation models (DEMs), delineate river terraces, alluvial fans, and badland topography.	**2**
	3. Paleoclimate Data Extraction: Foraminifera Analysis examine microscopic benthic and planktic foraminifera from deep-sea sediment core samples	**2**
	4. Coastal Geomorphology and Sea-Level Fluctuations analyze satellite imagery and topographic profiles of the Indian coastline Students analyze satellite imagery and topographic profiles of the Indian coastline map paleo-shorelines, raised beaches, and coral terraces to estimate the rate of Holocene sea-level changes	**2**
	5. Geoarchaeological and Paleolithic Site Analysis Using maps and lithic assemblages from classic Indian sites, students map artifact distributions against local paleodrainage networks	**2**
	6. Quaternary Chronology: Plotting: plot age-depth models, calculate sedimentation rates, and correlate them with regional abrupt climate change events	**2**
	Total	**12**

	VSC 301 GL T Natural Disaster Management	(Credits 2)
	VSC Theory	Hours: 30

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
CLO 1: Explain fundamental concepts such as hazard, disaster, vulnerability, risk and resilience in the context of natural disasters.
CLO 2: Describe the causes, processes and impacts of major geological and hydrometeorological hazards in India.
CLO 3: Analyze disaster risk using basic principles of hazard assessment and vulnerability evaluation.
CLO 4: Demonstrate understanding of technical tools such as Remote Sensing, GIS and early warning systems used in disaster management.
CLO 5: Interpret case studies of major disasters and evaluate mitigation and preparedness strategies.

Credit	Content	No of Lectures
I	**Foundation + Risk Analysis + Technical Tools**	
	C. Foundation of Disaster Studies • Concept of hazard, disaster, vulnerability, exposure and resilience • Types of disasters: Geological, Hydrological, Climatic • Disaster Management Cycle • Role of geologists in disaster mitigation	5
	D. Risk Analysis and Vulnerability Assessment • Elements of risk: Hazard × Vulnerability × Exposure • Hazard zonation concept • Community vulnerability mapping (basic approach) • Introduction to disaster risk reduction (DRR) • Case studies: a. Bhuj Earthquake (2001) b. Malin Landslide	5
	E. Technical Tools in Disaster Management • Basics of Remote Sensing and GIS • Early warning systems • Seismic monitoring basics • Flood forecasting concepts • Role of Indian agencies: c. National Disaster Management Authority d. India Meteorological Department	5

II	**Natural Hazard Studies + Management & Policy + Rehabilitation**	
	F. Natural Hazard Studies a.**Earthquakes** • Causes and seismic zones of India • Case: Latur earthquake b. **Landslides** • Causes and prevention • Himalayan vs Western Ghats context c.**Floods & Cyclones** • River floods and urban floods • Case: Mumbai Flood (2005) • Cyclone impacts in Odisha d. **Tsunami & Coastal Hazards** Case: Indian Ocean Tsunami	8
	G. Management, Policy and Rehabilitation • Disaster Management Act (2005) • Institutional framework (National, State, District) • Sendai Framework for DRR • Community-based disaster management • Post-disaster rehabilitation and reconstruction • Psychological and socio-economic recovery	7

Reference Books:

1. Alexander, D. (2002). *Principles of Emergency Planning and Management*. Oxford University Press, UK.
2. Government of India. (2005). *Disaster Management Act, 2005*. Ministry of Law and Justice, New Delhi.
3. Hinga, B. D. (2015). *Earth's Natural Hazards and Disasters*. Cengage Learning, USA.
4. Hyndman, D., & Hyndman, D. (2017). *Natural Hazards and Disasters*. 5th Edition. Cengage Learning, USA.
5. Keller, E. A., DeVecchio, D. E., & Blodgett, R. H. (2014). *Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes*. 4th Edition. Pearson Education, USA.
6. National Disaster Management Authority (NDMA). (Various Guidelines). Government of India, New Delhi.
7. Singh, R. B. (Ed.). (2006). *Natural Hazards and Disaster Management: Vulnerability and Mitigation*. Rawat Publications, Jaipur.
8. Smith, K., & Petley, D. N. (2013). *Environmental Hazards: Assessing Risk and Reducing Disaster*. 6th Edition. Routledge, London.
9. Subramanian, R. (2018). *Disaster Management*. Vikas Publishing House Pvt. Ltd., New Delhi.

	FP 301 GL P - Field Project and Scientific Report Writing	(Credits 2)
	Field Project	**Practicals: 15**

Course Outcomes (COs) On completion of the course, the students will be able to:	
CLO 1	To provide field experience about studying and identifying different geological features
CLO 2	To effectively collect and analyze data, demonstrate professional conduct in a field setting
CLO 3	To foster collaboration and communication skills
CLO 4	To build self-awareness through reflection on experiences within the field environment, structures and rocks
CLO 5	Understand the methodology of geological field investigations
CLO 6	Learn scientific report writing standards
CLO 7	Prepare professional geological project report

Topic of Practical	No of Practicals
Fundamentals of Geological Field Projects **1.1 Nature and scope of geological field work** • Importance in geosciences, Brief introduction of Types of field projects: Geological mapping, Hydrogeological survey, Environmental studies, Mineral investigation **1.2 Planning a field project:** Selection of study area, Literature review, Objectives and hypothesis formulation, Reconnaissance survey **1.3 Field safety and ethics:** Personal safety, Environmental ethics, Field discipline	2
Field Data Collection Techniques **2.1 Field equipment and their use:** Compass–clinometer, GPS basics, Field notebook, Measuring tape,Sample collection tools **2.2 Methods of field recording:** Field notes format, Litholog preparation, Field sketches, Structural measurements (basic) **2.3 Geological mapping basics:** Traversing methods, Outcrop description, Sampling strategy, Photographic documentation	2
Scientific Report Writing **3.1 Structure of a scientific report** • Title page • Abstract • Introduction • Study area description • Methodology • Results • Discussion • Conclusion • References • Appendices	2

3.2 **Scientific writing skills:** Technical language, Clarity and conciseness, Avoiding plagiarism, Citation styles (APA/Harvard) 3.3 **Preparation of illustrations:** Geological maps, Cross section, Tables and graphs, Figure captions	
A Geological field tour to be conducted in an area of geological interest for at least 3 to 5 days, and geological report to be submitted for the same. In addition to the requisite number of lectures and practicals, students are required to undertake a geological excursion to study geological structures and lithology firsthand under the guidance of a teacher. The fieldwork helps in developing individual skills of observation, description, and interpretation of geological features. Each student shall maintain a field diary for this purpose and shall write an area-wise report.	8
Total Practicals:	**12**

	MN 301 GL T - Petroleum Geology	(Credits 2)
	Minor Theory	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
CLO1: Identify and characterize source rocks and understand and assess the richness, quality, and thermal maturity of organic matter required for hydrocarbon generation.
CLO2: Differentiate reservoir rocks and evaluate the porosity, permeability, and diagenetic history of siliciclastic and carbonate reservoirs.
CLO3: Analyze migration pathways and diagnose structural, stratigraphic, and combination traps alongside the lithological integrity of seals.
CLO4: Understand reservoir categories and petroliferous basins of India

Credit	Content	No of Lectures
I	**Introduction** Origin of petroleum; Kerogen: Source Material and Formation, Composition and Distribution; Petroleum Chemical composition and physical properties of crudes oil	8
	Occurrence and movement/migration Occurrence of petroleum, nature of source rock; Reservoir fluids: Water, oil, and gas; Origin, migration, and accumulation of oil and natural gas.	7
II	**Reservoir Traps** Stratigraphic traps, structural traps and combination traps	8
	Petroliferous Basins of India Bombay basin; Krishna-Godavari basin; Assam basin; Cauvery basin and Rajasthan basin	7

	Reference Books:
	1. Tissot, B.P. and Welte, D.H. (1984) Petroleum Formation and Occurrence, Springer- Verlag, Berlin. 2. Levorsen, A.I, (2004) Geology of Petroleum, CBS Publishers and Distributors 3. North, F.K. (1986) Petroleum Geology, Allen & Unwin, London. 607p 4. Hunt, J.M. (1996) Petroleum Geochemistry and Geology, W.H. Freeman 5. Selley, R.C., 1998, Elements of Petroleum Geology: W.H. Freeman & Company,NY.

Semester VI

	GL 351 T - Geology of India II	(Credits 2)
	Major Theory	**Hours: 30**

Course Learning Outcomes (CLOs). On completion of the course, the students will be able to:	
CLO 1	Stratigraphic study of the Proterozoic basin of India.
CLO 2	To understand the Phanerozoic study of India
CLO 3	To study Extra-Peninsular India
CLO 4	To study the Geology and Stratigraphy of Maharashtra

Credit	Course Contents	No of Lectures
I	**The Paleozoic and Mesozoic Formations of Peninsular India** A) Paleozoic Formations of Peninsular India a) A brief history of the Paleozoic Formations, b) Gondwana Supergroup: 1.Geographical distribution, 2. Stratigraphic classification, 3.Lithology, 4. Age, 5.Palaeoclimatic conditions, 6. Flora, 7.Fauna, 8. Igneous activity, 9. Marine intercalations, 10. Economic importance. B) The Mesozoic Formations of Peninsular India: a) A brief history of the Mesozoic formations b) Jurassic of Kachchh c) Cretaceous of Narmada Valley/Bagh beds. d) Cretaceous of Cauvery basin	**15**
II	**Cenozoic Formations of Peninsular India** A) The Deccan Volcanic Province : Distribution, extent, age, structure, mode of eruption and occurrence, Petrological characters and variations, Lithostratigraphic classification, Infratrappeans and Intertrappean beds. B)The Cenozoic Formations of Peninsular India: a) Tertiary of Assam b) Tertiary of the K-G basin **The Phanerozoic Stratigraphy of Extra-Peninsular India:** Classification, lithological succession and fossil content of the: a) Spiti basin, b) Siwalik Group **The Geology and Stratigraphy of Maharashtra**	**15**

	Reference Books:
	1. G.G. Deshpande (2002): Geological of Maharashtra- Geological Society of India – Special Publication. 2. K.S. Valdiya (2010), The Making of India – Geodynamic evolution. Springer 3. Fundamentals of historical geology and Stratigraphy of India, Ravindra Kumar 4. Geology of India Volume I & II- Vaidyanathan and Ramakrishnan 5.Naqvi, S.M., 2005. Geological Evolution of the Indian Plate (From Haedean to Holocene -4Ga to 4Ka)

	GL 352 T - Economic Geology and Mineral Deposits	(Credits 2)
	Major Theory	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
CLO1: The course provides the student with essential and basic concepts of mineral expiration techniques and the art and science of mining mineral resources.
CLO2: Students must analyse the genetic mechanisms, tectonic settings, and geochemical conditions that concentrate minerals into economic deposits.
CLO3: By the end of this course, geology students must be able to classify ore-forming systems, evaluate the commercial viability of mineral deposits, and apply exploration field techniques.

Credit	Content	No of Lectures
I	**Mineral forming processes -I** a) Definition of ore minerals, gangue, tenor, overburden, country rock, syngenetic & epigenetic deposits. b) Classification of economically important metalliferous & non metalliferous mineral deposits. **Magmatic Concentration:** a) Early magmatic deposits; b) Late magmatic deposits **Hydrothermal processes:** a) Principles of hydrothermal processes, characteristics of solutions, types of openings in rocks, factors affecting deposition from hydrothermal solutions, and wall rock alternations. b) Types of hydrothermal deposits 1. Cavity filling deposits: • Processes & characteristic features • Types of cavity filling deposits: Fissure veins & its types (in brief), stock work, saddle reefs, ladder veins, pitches and flats, breccia filling deposits, solution cavity fillings, pore space fillings & vesicular fillings 2. Metasomatic replacement: Definition, Criteria of replacement& resulting mineral deposits.	8
	Oxidation & Supergene enrichment: a. Oxidation& solution in the zone of oxidation b. Gossans & Cappings, the role of iron in gossans, indigenous& transported limonite, false gossans & gossans as guides to the hidden deposits. c. Ore deposition in the zone of oxidation & their method of precipitation d. Supergene Sulphide Enrichment: 1. Requirements for supergene enrichment 2. Factors influencing supergene enrichment. 3. Recognition of supergene enrichment	7

II	Mineral forming processes -II **A) Evaporation, Residual concentration & Mechanical concentration:** a. Evaporation: 1. Process of mineral formation by evaporation 2. Evaporation deposits: Brief account of deposits of oceanic water, lake water, ground water & hot springs b. Residual concentration (residual deposits): 1. Conditions favouring of residual deposits 2. Brief account of residual deposits: Bauxite, clay & iron formation c. Mechanical concentration (placer deposits): 1. Principles involved in the process of mechanical concentration 2. Study of placer deposits: Eluvial, Alluvial, Beach &Aeol **B) Study of the following metallic deposits with reference to mineralogy, properties, uses & their geological & geographical distribution** a. Precious metals: Gold, Silver. b. Non-ferrous metals: Copper, Lead, Zinc & Aluminium c. Iron & Ferro alloy metals – Iron, Manganese, Nickel & Chromium	5 3
	C) Study of the following non-metallic deposits with reference to mineralogy, properties, uses & their geological & geographical distribution Muscovite, Gypsum, **D) Radioactive minerals:** a. Study of Uranium & Thorium deposits of India with reference to mineralogy, mode of occurrence, properties, uses & their geological & geographical distribution **E) Introduction to Geophysical and Geochemical methods for mineral** exploration **F) Environmental and social issues related to mineral resource extraction**	7

	References:
	1. Jeason and Bateman (1981) Economic mineral deposits, John Wiley and Sons 2. Gokhale &Rao (1978) Ore deposits of India, Thomson press (India) limited. 3. Krishnaswamy, Subbier (1979) *India's mineral resources*, 2d edition: New Delhi, Oxford and IBH Publishing 4. D. N.Wadia (1966) India's Minerals, National Book Trust 5. Robert L. Bates (1969) Geology of the industrial rocks & minerals, Dover Publications 6. Umeshwar Prasad (2003) Economic Geology, Satish Kumar Jain, CBS Publishers and Distributers. 7. Umate (IBM) : Economic mineral deposits of India 8. Park & Mc-dermitt (1997): Economic Ore Deposits 9. Tiwari, S.K (2010): Ore Geology, Economic Minerals and Mineral Economics 10. Aswathanarayana, U. (2005): Mineral Resources Management and The Environment 11. Guilbert, John M. and Charles Frederick Park (2007): The Geology of Ore Deposits 12. Arogyaswamy R.N.P (2017): Courses in Mining Geology

	GL 353 T - Climatology	(Credits 2)
	Major Theory	**Hours: 30**

Course Outcomes (COs) On completion of the course, the students will be able to:	
CLO 1	To Describe the structure and composition of the atmosphere
CLO 2	Explain heat budget and atmospheric circulation
CLO 3	To interpret weather systems and precipitation processes
CLO 4	To Describe climatic classification with special reference to India
CLO 5	To evaluate causes and impacts of climate change

Credit	Contents	No of Lectures
I	**Introduction to Climatology and Atmosphere** **1.1 Climatology: Definition, scope, and relationship with meteorology** 1.2 **Composition and structure of the atmosphere:** Major gases, Vertical structure (Troposphere to Exosphere), Temperature variation with height 1.3 **Elements of weather and climate:** Temperature, Pressure, Wind, Humidity, Precipitation 1.4 **Insolation and Earth's heat budget:** Solar radiation, Heat balance of the Earth, Factors affecting temperature distribution **Atmospheric Processes and Circulation in brief:** **2.1 Atmospheric pressure:** Measurement and distribution, Pressure belts of the world **2.2 Winds:** Forces controlling wind, Planetary winds, Monsoon winds (introductory), Local winds **2.3 Atmospheric humidity:** Measures of humidity, Condensation processes, Cloud formation	15
II	**Precipitation and Weather Systems** **3.1 Types of precipitation:** Convectional, Orographic, Cyclonic **3.2 Air masses and fronts** **3.3 Cyclones and anticyclones:** Tropical cyclones, Temperate cyclones, Anticyclones **3.4 Thunderstorms and western disturbances** **Climate Classification, Indian Climate and Climate Change** **4.1 Climatic classification:** Köppen classification, Thornthwaite classification **4.2 Climate of India:** Controls of Indian climate, Indian monsoon mechanism, Seasonal climatic conditions **4.3 Climate change and global warming:** Causes (natural and anthropogenic), Greenhouse effect, Evidence of climate change, Impacts on water resources and geology **4.4 Applied climatology in Earth sciences:** Agriculture, Hydrology Natural hazards	15

	Reference Books:
	1. Climatology, D.S Lal 2. General Climatology, H.J.Critchfield 3. Climatology K. Siddartha 4. Global Physical Climatology, Dennis L. Hartmann

	GL 354 T - Petroleum and Coal Geology	(Credits 2)
	Major Theory	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
CLO1: **Evaluate** the physical and chemical conditions necessary for the formation, maturation, and preservation of both coal deposits and hydrocarbon reservoirs.
CLO2: **Analyze** sedimentary basin histories to predict the presence, migration pathways, and structural or stratigraphic trapping mechanisms of petroleum systems
CLO3: Differentiate between various types, ranks, and lithotypes of coal using industrial classification standards and megascopic identification parameters.
CLO4: **Utilize** organic petrography and reflected light microscopy techniques to successfully identify coal macerals
CLO5: Student will understand and learn about the basic concepts of Petrology Geology with respect to geology as to enable them to work as a Petroleum Geologist.

Credit	Course Contents	No of Lectures
I	**Origin of Petroleum** Origin of petroleum; Kerogen: Source Material and Formation, Composition and Distribution; Petroleum Chemical composition and physical properties of crudes oil **Occurrence of petroleum,** nature of source rock; Reservoir fluids: Water, oil and gas; Origin, migration and accumulation of oil and natural gas.	8 7
II	**1. Introduction and Origin of Coal** Definition and Scope: Definition of coal, coal geology as an interdisciplinary science. Origin of Coal: Theories of coal formation; Processes: Biochemical stage and Geochemical stage **2.Physical and Chemical Properties of Coal** Rank and Grade of coal. Coalification Series: Physical Properties and Chemical Analysis **3. Coal Petrology** •Megascopic Components (Lithotypes): •Microscopic Components (Maceral Concept): **4. Coal Deposits and Sedimentology** •Coal-bearing Sequences: Depositional environments (peat swamps, deltaic, lacustrine). •Structural Control: Effect of tectonics on coal basin development. •Coalbed Methane (CBM): Introduction to CBM, its generation, and storage. •Coal Deposits of India: Major coalfields (Gondwana and Tertiary coalfields).	4 3 4 4

	Reference Books:
	1.Tissot, B.P. and Welte, D.H. (1984) 2. Petroleum Formation and Occurrence, Springer- Verlag, Berlin. 3. Levorsen, A.I, (2004) Geology of Petroleum, CBS Publishers and Distributors 4. North, F.K. (1986) Petroleum Geology, Allen & Unwin, London. 607p 5. Hunt, J.M. (1996) Petroleum Geochemistry and Geology, W.H. Freeman 6. Selley, R.C., 1998, Elements of Petroleum Geology: W.H. Freeman & Company,NY. 7. Stach, E. et al. Stach's textbook of coal petrology. Berlin: Gebruder Borntraeger, 1 8. Taylor, G.H., Teichmüller, M.., Davis, C. Organic Petrology: A new handbook incorporating some revised parts of Stach's Textbook of Coal Petrology, 1998 9. Chandra, D., Singh, R.M., Singh, M.P. Text Book of Coal (Indian Context). Tara Printing Works, Varanasi, 2000

GL 355 P Practicals related to GL 351 T, GL 352 T, GL 353 T and GL 354 T **Total Credits = 4**

Practicals related to GL 351 T Geology of India II	**Credits 1**

Topics	**No. of Practicals**
Phanerozoic Indian Stratigraphy: **Preparation of maps showing geographical distribution of the following stratigraphic units of India** **a.** Palaeozoic of Spiti b. Gondawana Supergroup, c. Jurassic of Kachchh, Cretaceous of Caveri Basin, Bagh Beds, d. Deccan Traps, e. Siwaliks	**2**
Study of typical hand specimens of rocks from different lithological units of Phanerozoics of India. Gondwana Supergroup, Jurassics of Kachchh and Rajasthan, Cretaceous of Narmada Valley/Bagh beds, Deccan Volcanic province, Cenozoic formations.	**2**
Interpretation of geological map of India	**1**
Study of Gondwana flora	**1**
Total No. of Practicals	**6**

Practicals related to GL 352 T Economic Geology and Mineral Deposits	**Credits 1**

	Content	**No of Practicals**
	Study of ore minerals in hand specimen (at least 8). Haematite, Magnetite, Galena, Sphalerite, Chromite, Pyrolusite, Malachite & Bauxite	2
	Study of industrial minerals in hand specimen (at least 8). Muscovite, Gypsum, Baryte, Calcite/Dolomite, Asbestos, Fluorsopar, Wollastonite, Kyanite, Coal.	1
	Preparation of mineral maps of India showing occurrences of Ore and industrial minerals.	1
	Mineralogical & textural study of common Ore minerals/industrial minerals under microscope.	1
	Preparation of charts showing specifications of materials required for different industries.	1
	Total	**6**

Practicals related to GL 353 T Climatology	**Credits 1**

	Content	**No of Practicals**
	Preparation and interpretations of Isotherm and Isobar on map. Atmospheric Circulation & Global Wind Belts. Connect Earth-Sun geometry to global pressure systems and wind patterns.	1
	Distribution of major wind patterns on World map.	1
	Preparation of paleogeographic maps (distribution of land and sea) of India during specific geological time intervals.	1
	Numerical exercises on interpretation of proxy records for paleoclimate.	1
	Construction and Interpretation of Wind Rose Diagrams	1
	Stratigraphic Paleoclimate Analysis Objective: Reconstruct past climates by analysing sedimentary lithofacies.	1
	Total	**6**

Practicals related to GL 354 T Petroleum and Coal Geology	Credits: 1

	Content	No of Practicals
	Determination of porosity and permeability by crude method / core samples, Numerical problems based on porosity and permeability	1
	Study of Isopach maps	1
	Panel / Fence diagrams	1
	Study of Petroliferous basins of India	1
	Megascopic Identification of Coal Ranks Learn to distinguish between different types and ranks of coal based on physical properties (luster, color, fracture, and hardness).	1
	Reserve Estimation & Proximate Analysis Calculation Calculate the tonnage and commercial quality of coal deposits. • Study of coal fields of India	1
	Total	**6**

	GL 361 T ME - Geotechnical Studies	(Credits 2)
	Major Elective	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:	
CO1	Identify the engineering properties of rocks
CO2	Explain rock mass characterization
CO3	Execute slope stability analysis
CO4	Plan and carry out geotechnical investigation in the field.
CO5	Evaluate geological data for appropriate sites to build various engineering structures
CO6	Synthesis geological and engineering data to determine suitability of site

Credit	Content	No of Lectures
I	**Rock Mass Characterization** Scope of Engineering Geology. Engineering properties of rocks. Methods of determining engineering properties of rocks.	7
	Behaviour of rocks under stress. Rock failure mechanisms. Engineering properties of soils. Methods of soil investigations.	8
II	**Drilling in geotechnical field and Drilling Equipments**, Rock Quality Designation (RQD) and Core Recovery (CR) Core logging and bore logging RMR (Rock Mass Rating) (Bienawiski, 1989) Types of Foundations and Safe Bearing Capacity Laboratory and field Geotechnical test	7
	Introduction to Piling Packer Permeability Test (P.P.T)., Standard Penetration Test and its types. (S.P.T.) b. Sieve analysis of Soil c. Specific Gravity by Pycnometer d. Determination of Field Density by Core cutter method and Sand Replacement method Determination of Compaction properties of Soil by standard proctor Test	8

	Reference Books:
	1. Blyth, F G H. A geology for engineers. -7th ed 2. Krynine and Judd: Principles of Engineering Geology and Geotechniques. 3. Parbin Singh, Engineering Geology, 4. S.K.Kataria& Sons Rise and Watson: Elements of Engineering Geology.

	GL 362 T ME – Watershed Management	(Credits 2)
	Major Elective	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:	
CO1	Describe the status of groundwater in India and the world.
CO2	Discuss basic concepts related to groundwater development and management.
CO3	Illustrate the concept of managed aquifer recharge, participatory groundwater management .
CO4	Compare the status of groundwater in various physiographic divisions of India.
CO5	Determine appropriate techniques for groundwater development and management.
CO6	Perform hydrogeological surveys and prepare field reports.

Credit	Content	No of Lectures
I	**Watershed Development** Groundwater provinces of India, Concept of watershed and watershed development measures, Integrated Watershed Management Program (IWMP), Managed Aquifer Recharge, Types of recharge methods: Water spreading methods: Recharge through Pits & Shafts, Recharge through wells, Rainwater harvesting, Groundwater recharge methods in Maharashtra	8
	Significance of geology in watershed development Assessment of water resources, i.e., surface water and groundwater in a watershed: rainfall-runoff and groundwater analysis e. Role of NGO"s and State Government in watershed development	7
II	**Watershed Management** Concept of watershed management in relation to water resources. b. Water balance equation for watershed, sustainability of water resources, and conjunctive use of surface and groundwater resources.	8
	Watershed Modelling Drought assessment and management Integrated watershed management	7

	Reference Books:
	1. Brooks, K.N. Folliott, P.F., Magner, J.A. (2012) Hydrology and the Management of Watersheds, John Wiley & Sons 2. Murthy, J.V.S. (2012) Watershed Management New Age International Publisher 3. Heathcote, I.W. (2009) Integrated Watershed Management: Principles and Practice, John Wiley & Sons Ltd 4. Debarry, P. A. (2004) Watersheds: Processes, Assessment and Management, Wiley 5. Naiman, R.J. (1994) Watershed Management: Balancing stainability and Environmental Change, Springer 6. Gonenc, I.E., Vadineanu, A., Wolflin, J.P. (2014) Sustainable Use and Development of Watersheds, Springer 7. Raghunath H.M. (2003) Groundwater, New age education.

	8. Karanth K.R. (1987) Groundwater assessment development and management, Tata Mcgrath Hill education. 9. Todd, D. K. and Mayo, L. W. (2004) Groundwater hydrology, Wiley.

	GL 363 ME Analytical Methods in Geology	(Credits 2)
	Major Elective	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
CLO 1: Explain the importance of analytical methods in geological investigations and describe common units of geochemical measurements (wt%, ppm, ppb) and classification of elements (major, minor, trace, and rare earth elements).
CLO 2: Describe principles of representative sampling and outline standard procedures for sample collection, preparation, and handling of geological materials.
CLO 3: Interpret the concepts of data quality including accuracy, precision, errors, calibration, and quality control in analytical measurements.
CLO 4: Explain the basic principles of spectroscopic techniques and instrumental methods used for bulk and micro-analysis of geological samples.
CLO 5: Recognize the applications of analytical techniques such as XRF, XRD, SEM, and ICP-MS in mineralogical, geochemical, and environmental studies.

Credit	Content	No of Lectures
I	**A. Introduction** • Scope and importance of analytical methods in geology • Role of analytical techniques in mineralogy, petrology, geochemistry, and environmental geology • Types of geological materials: rocks, minerals, sediments, water • Units of Measurement in Geochemistry: Weight percent (wt%), Parts per million (ppm), Parts per billion (ppb), Conversion between units (simple numerical examples) Classification of Elements in Geological Materials: Major elements, Minor elements, Trace elements, Rare Earth Elements (REE) – light and heavy REE (conceptual introduction)	4
	B. Sampling Strategy • Principles of representative sampling • Random vs systematic sampling • Field sampling of rocks, soils, stream sediments • Avoiding contamination and bias Sample labeling, documentation and preservation	3
	C. Sample Preparation • Crushing, grinding and homogenization • Sieving and grain size control • Powder preparation for XRD/XRF • Thin section preparation (overview) Digestion methods for geochemical analysis (basic idea only)	4
	D. Data Quality • Accuracy vs precision • Types of errors (systematic & random) • Calibration and standards • Detection limits • Basic statistical treatment of analytical data • Quality control and quality assurance (QA/QC)	4

II	E. Spectroscopy Basics • Electromagnetic spectrum overview • Interaction of radiation with matter • Absorption, emission, fluorescence • Concept of spectra and elemental identification	3
	F. Bulk Analysis (Whole rock / bulk composition techniques) • X-Ray Fluorescence (XRF): Principle and applications • X-Ray Diffraction (XRD): Principle and mineral identification • ICP-OES / ICP-MS (introductory overview) • Applications in whole-rock geochemistry	4
	G. Micro-analysis • Optical microscopy (brief revision in analytical context) • Scanning Electron Microscopy (SEM) • Electron Probe Micro-Analyzer (EPMA) • Applications in mineral chemistry	4
	H. Advanced Applications (Conceptual and application-based — not technical depth) • Isotope analysis (radiometric dating overview) • Trace element analysis and REE patterns • Environmental geochemical monitoring • Ore characterization and mineral exploration	4

Reference Books:

1. Albarède, F. (2003). Geochemistry: An Introduction. Cambridge University Press.
2. Gill, R. (1997). Modern Analytical Geochemistry: An Introduction to Quantitative Chemical Analysis Techniques for Earth, Environmental and Material Scientists. Longman.
3. Krauskopf, K. B., & Bird, D. K. (1995). Introduction to Geochemistry. McGraw-Hill.
4. Rollinson, H. (1993). Using Geochemical Data: Evaluation, Presentation, Interpretation. Longman Scientific & Technical.
5. Christian, G. D. (2004). Analytical Chemistry. John Wiley & Sons.
6. Gill, R. (2015). Chemical Fundamentals of Geology. Wiley-Blackwell.
7. Jenkins, R. (1999). X-Ray Fluorescence Spectrometry. Wiley-Interscience.
8. McLennan, S. M., & Taylor, S. R. (1989). Principles of Geochemical Analysis. Academic Press.
9. Potts, P. J. (1992). A Handbook of Silicate Rock Analysis. Blackie Academic & Professional.
10. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). Principles of Instrumental Analysis. Cengage Learning.

GL 364 T ME - ENVIRONMENTAL GEOLOGY AND SUSTAINABILITY	(Credits 2)
Major Theory/Minor Elective	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:	
CLO 1	Understand the fundamental concepts of environmental geoscience, its scope and necessity
CLO 2	Know the fundamentals of earth science as applied to the interaction between human activity and the natural environment.
CLO 3	Acquainted with different biogeochemical cycles like carbon, nitrogen, phosphorus and sulfur.
CLO 4	Study in detail major societal burning issues including Water, Soil, and Air pollution.
CLO 5	Students will be able to understand the Importance of Sustainability
CLO 6	Relate environmental issues to the context of Sustainability
CLO 7	Analyze the strategies for the Sustainable Development

Credit	Content	No of Lectures
I	**Concept, Objective and Scope of Environmental Geology:** **A)** Seven concepts, Objectives, and Scope of Environmental Geology; Physical, Biological, and Socio-geological Environment, Bio-geochemical cycles. **B)** Deterioration of land surface: Dimensions of Erosion, processes, causes of accelerated erosion, remedial measures. **C)** Desertification and degradation of land: meaning, extent, causes and preventive measures. **D)** Ozone Depletion	8
	E) **Pollution:** a) **Water Pollution:** Water quality parameters, BIS standards Sources of water pollution (natural and man-made), Case histories related to water pollution: Minamata disease (Japan), Arsenic poisoning (West Bengal), and Flourosis (Bhandara) b) **Soil Pollution:** Sources of soil pollution (use of pesticides, fertilizers, industrial domestic water, and their effects c) **Air pollution:** Air Quality Index**,** Sources of air pollution, (aerosols, particulate matters in urban and industrial area), case histories: Chernobyl disaster and Bhopal gas disaster	7

II	**Sustainability** 1. Sustainable Development: Definition, Scope and Emerging Trends. Environmental Scenario: Case study of India 2. Strategies for Sustainable Development: a) Conservation and development of natural resources, Crises faced by mankind with regards to conventional and non-conventional energy resources b) Soil conservation, badland topography, alkalinity and salinity of soils	8
	c) Water resources Management: Methods of Surface Rain Water Harvesting (Gabion Structure, Gully Plug, Check Dam ,Contour Bund , Percolation Tank , Mini-Hydel Plants) Solid waste disposal: Solid waste disposal methods (deep well disposal, ocean dumping, hazardous chemical wastes), its effects with geological perspective	7

	Reference Books:
	1. Selby, M.J., (1996) Earths Changing Surface. Oxford University Press UK. 2. Thornbury W. D., (1997) Principles of Geomorphology Wiley Eastern Ltd., New Delhi. 3. Valdiya, K. S., (1987) Environmental Geology - Indian Context. Tata McGraw Hill New Delhi. 4. Keller, E. A., (2000) Environmental Geology. Shales E. Merril Publishing Co., Columbus, Ohio. 5. Montgomery, C., (1984) Environmental Geology. John Wiley and Sons, London. 6. Sharma J. P., Environmental Studies, Laxmi Publications (P) Ltd, New Delhi 7. Center for Science and Environment https://www.cseindia.org/

Paper Code: GL 365 P ME Practical related to Major Elective	**(Credits 2)**

Practicals related to Geotechnical Studies	

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
Determine RQD from given data and critique about site selection for construction of engineering structures from geological data.

	Content	**No of Practicals**
	Site suitability for construction of large engineering projects.	**2**
	Preparation of subsurface map, correlation and interpretation for construction of large engineering Projects - I	**3**
	Preparation of subsurface map, correlation and interpretation for construction of large engineering Projects - II	**3**
	Study of physical and engineering properties of rocks. Study of physical and engineering properties of rocks.	**2** **2**
		12

Practicals related to Watershed Management	

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
Developed extensive subject knowledge in various field of Watershed Management. Demonstrate personal accountability and effective work habits, e.g., time and work planning as well as punctuality and working productively with different components Watershed Management enables you to think at a higher level and act locally as individual and as citizens you need to be aware of the nature around you as well as to make the right decisions about the environment and the important elements of nature.

	Content	**No of Practicals**
	Surveying and preparation of watershed map.	1
	Grid survey of watershed area.	1
	Preparation of contour map and delineation of watershed.	2
	Delineation of watersheds using toposheets.	1
	Quantitative analysis of Geo-morphological characteristics of watershed.	2
	Analysis of hydrologic data for planning of watershed development.	1
	Water budgeting of watersheds.	2
	Study of watershed management technologies.	1
	Visit to watershed development project	1
		12

Practical Related to Analytical Methods in Geology	

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
CLO 1: Apply appropriate sampling strategies and sample preparation techniques for geological materials to obtain representative samples for analysis.
CLO 2: Perform basic geochemical calculations and data conversions, including unit conversions, elemental ratios, and normative mineral calculations.
CLO 3: Evaluate analytical data quality using statistical methods such as mean, standard deviation, and relative standard error.
CLO 4:Develop an understanding of the analytical workflow in geology, from field sampling to laboratory analysis and data interpretation.

	Content	**No of Practicals**
	Sampling & Preparation P1: Field Sampling Protocol Simulated exercise on selecting representative rock samples from a heterogeneous outcrop and labeling for the lab. P2: Rock Crushing & Pulverization Demonstration of using a Jaw Crusher and Ball Mill; understanding the "Mesh Size" and preventing cross-contamination. P3: Cone and Quartering Method Practical application of reducing a large bulk sample into a statistically representative sub-sample for analysis. P4: Loss on Ignition (LOI) Determination Heating rock powder in a muffle furnace to determine the weight percentage of volatile components (H2O, CO2).	**4**
	Geochemical Calculations **P5: Unit Conversions & Elemental Ratios** Converting Weight Percent (wt%) to Parts Per Million (ppm) and calculating molar ratios (e.g., Mg#). **P6: Normative Mineral Calculation (CIPW Norm) from Major Oxide Data** Converting a bulk chemical analysis (major oxides) into a theoretical mineral assemblage (Normative Mineralogy). **P7: Statistical Assessment of Analytical Data** Calculating Mean, Standard Deviation, and Relative Standard Error (RSE) for a set of replicate analyses.	**3**
	Instrumental Analysis & Interpretation **P8: Interpretation of XRD Patterns** Identifying mineral phases in a powder sample by comparing d-spacing peaks with standard JCPDS cards. **P9: XRF Data Plotting (Harker Diagrams)**	**5**

	Using Harker Diagrams to plot major oxides and interpret igneous differentiation trends. **P10: SEM-EDS Mineral Identification** Analyzing a back-scattered electron (BSE) image to identify mineral grains based on chemical spot analysis. **P11: REE Normalization & Chondrite Plotting** Plotting Trace Element data on a spider diagram to identify anomalies (e.g., Europium anomaly). **P12: Isotope Data Interpretation** Calculating a simple Isochron Age from provided Rb-Sr or Sm-Nd isotopic ratios.	
		12

Practicals related to ENVIRONMENTAL GEOLOGY AND SUSTAINABILITY

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:

CLO1: Assess soil, water, and air quality using standard geological field equipment and laboratory analytical techniques to identify pollution levels and environmental degradation.

CLO2: Evaluate the physical mechanisms behind land degradation, erosion, and badland topography formation using scaled physical models and geospatial observations.

CLO3: Design and test low-cost, geologically-based remediation strategies, such as soil filtration, landfill liners, and erosion control mechanisms, to mitigate human-induced land and water pollution.

CLO4: Quantify resource consumption, carbon footprints, and urban heat dynamics using empirical data to formulate actionable sustainability and climate adaptation plans.

CLO5: Synthesize experimental laboratory data into professional scientific reports that communicate environmental risks and sustainable solutions clearly to both technical and non-technical stakeholders.

	Content	**No of Practicals**
	Water Quality and Filtration Analysis Test and purify contaminated water	**1**
	Soil Texture and Heavy Metal Leaching Separate soil into sand, silt, and clay fractions using jar sedimentation tests	**1**
	Particulate Matter (PM) Air Mapping, Quantify visual air pollution in different zones Deploy index cards covered in petroleum jelly across industrial, residential, and green spaces.	**2**
	Landfill Leachate and Land Pollution Simulation Construct a mock landfill in a transparent container with layered soil, rock, and waste.	**2**
	Carbon Sequestration Potential of Local Rocks Test geological materials for their ability to trap carbon dioxide.	**2**
	Household Carbon and Ecological Footprint Audit Track one week of utility bills, driving distances, and physical waste weight	**2**
	Urban Heat Island and Permeable Surface Mapping Use infrared thermometers to measure surface temperatures of concrete, asphalt, grass, and bare soil.	**2**
	Total	**12**

	VSC 351 GL T – GIS and Geoinformatics	(Credits 2)
	Vocational Skill Courses	**Hours: 30**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:
CLO 1 Understand the concepts of GIS and Geoinformatics
CLO 2 Describe GIS components and software ecosystem
CLO 3 Interpret vector and raster data structures
CLO 4 To explain spatial analysis and georeferencing concepts
CLO 5 To apply GIS concepts in geological problem

Credit	Content	No of Lectures
I	**1. Introduction to Geoinformatics and GIS** **1.1 Geoinformatics: Definition, scope and applications:** Components of Geoinformatics, Role in Earth Sciences, Integration of GIS, Remote Sensing and GPS **1.2 GIS: Definitions and evolution:** History and development of GIS, Objectives and functions of GIS, Advantages and limitations **1.3 Components of GIS:** Hardware, Software, Data, People, Methods **1.4 Overview of GIS software packages**: Proprietary vs Open-source GIS, Desktop vs Web GIS, Introduction to major GIS platforms	7
	2. Open-Source GIS and QGIS Environment: **2.1. Open-source software concepts:** Definition and philosophy, Advantages of open-source GIS, Licensing basics **2.2 Introduction to QGIS:** Features and capabilities, and Applications in geology **2.3 QGIS interface:** Menu bar, Toolbars, Layers panel. Map canvas, Browser panel **2.4 QGIS Plugins:** What are plugins?, Installing and managing plugins, Important plugins for geoscience (overview)	8
II	**3. Spatial Data Models and Visualization** **3.1 Spatial data types:** Vector data model (point, line, polygon), Raster data model, Attribute data **3.2 Data input concepts:** Importing spatial data, Coordinate reference system (CRS) basics, Map projections (brief) **3.3 Data visualization principles:** Layer symbology, Labeling concepts, Map composition and layout design, Elements of a good map **3.4 Georeferencing concepts:** Need for georeferencing, Ground Control Points (GCP), Transformation methods, Accuracy considerations	8

	4. Spatial Analysis and Data Editing Concepts **4.1 Vector data operations:** Creation of vector layers, Spatial queries, Attribute queries, Buffer, overlay **4.2 Raster data concepts:** Raster symbology, DEM and terrain analysis (slope, aspect – concept), Raster calculations (overview) **Editing and data management:** Feature selection, Basic editing	7

	Reference Books:
	1. An Introduction to Geographical Information Systems, Heywood, Cornelius & Carver. 2. Introduction to Geographic Information Systems, Kang-tsung Chang 3. Concepts and Techniques of Geographic Information Systems, Lo & Yeung 4. Remote Sensing and GIS, Oxford University Press, Basudeb Bhatta

	Course Code: GL 371 OJT - On Job Training	(Credits 4)
	On Job Training	Hours: 120

Objectives and Vision

Internships serve as pivotal educational and career development opportunities, offering hands-on experience in specific fields or disciplines.

They are structured, short-term, supervised internships often centred on particular tasks or projects with predefined time frames.

An internship may be compensated, partially compensated, or unpaid; however, it must be meaningful and beneficial to both the intern and the hosting organization.

Following are the objectives of the Internships envisaged for the students enrolled in the University:

i. Relate knowledge and understanding acquired in the classroom to the performance of related jobs in their natural setting

ii. ii. Exposing students to industrial environments that cannot be replicated in a classroom.

iii. iii. Providing opportunities to acquire and refine analytical and managerial skills crucial for a professional career.

iv. iv. Offering hands-on experience in teamwork, thereby enhancing professional skills like communication, work ethics, conflict resolution, etc., with a lasting impact on lifelong learning and professional development.

v. v. Gain an understanding of specific trade and the various practices and protocols within the chosen industry

vi. vi. Establishing links between students and potential future job or research opportunities.

	Benefits of the OJT / Internship
	The major advantages of On-the-Job Training include the following: 1. It is relevant to the subject and the competencies to be acquired by the trainees, as it is directly in the context of job. 2. It is most effective because it is learning by experience. 3. Trainees are more likely to retain the knowledge and skills, as they learn through hands on 4. Training. 5. Trainees become highly motivated and develop self-confidence 6. It helps trainees to understand and learn about the new tasks and skills that will help them to 7. adapt to the new project more effectively 8. It is useful in reducing the cost of training 9. Trainees can also get an opportunity to earn while they learn through stipends / consultancies.