CENTRAL UNIVERSITY OF TAMIL NADU

Curriculum
for
B.Sc. Honours and
B.Sc. Honours with Research
Effective from 2026-27 AY

Department of Geology
School of Earth Sciences
Central University of Tamil Nadu
Thiruvarur-610005, Tamil Nadu

CENTRAL UNIVERSITY OF TAMIL NADU

1. VISION

To produce and sustain the conditions that enable the students to experience the transformative learning in becoming an independent and ideal learner through the education of global standards. This would be achieved by maintaining high academic standards, sustaining the quality of scientific teaching and learning offered, and providing an intellectual, personal, and social transformative experience to students.

2. MISSION

M1 To provide a student-centric learning environment through scientific and innovative pedagogy

M2 To create excellent infrastructure facilities and state-of-the-art laboratories

M3 To encourage research and industry-institute partnerships through collaborative activities for innovation and development

M4 To promote conferences/seminars/workshops/society development programs for creation of avenues for research exchange and knowledge enhancement in thrust areas

M5 To enhance leadership qualities, ethical and moral values, research culture and innovative skills among the students by offering high quality education and other services in a competitive manner

3. ABOUT THE DEPARTMENT

The Department of Geology at the Central University of Tamil Nadu was established in 2019, with the vision of offering high-quality education and research in Earth Sciences. Since its inception, the department has focused on building a strong academic foundation through its comprehensive programmes that blend classroom teaching, laboratory training, and extensive fieldwork. Equipped with modern laboratories and field instruments, the department is committed to advancing geological knowledge and addressing emerging scientific and environmental challenges of the 21st century. In alignment with the National Education Policy (NEP) 2020, the Department of Geology aims to provide an interdisciplinary and application-oriented learning experience that prepares students for careers in geoscience, natural resource management, environmental consultancy, and research. The Department of Geology introduces a new Four-Year B.Sc. (Hons.) Geology programme is aligned with the National Education Policy (NEP) 2020, offering a comprehensive and interdisciplinary foundation in Earth

Sciences from the academic year 2026-2027. The curriculum emphasizes core areas such as mineralogy, petrology, structural geology, sedimentology, palaeontology, geophysics, hydrogeology, remote sensing and GIS, coal and petroleum, mining and engineering geology, and environmental geology, ensuring that students gain a thorough understanding of both theoretical and practical aspects of Earth Science. Through regular field courses, laboratory sessions, and research-driven projects, the department offers ample opportunities for students to develop scientific skills, analytical abilities, and a deep appreciation of Earth's dynamic systems.

4. RATIONALE OF THE B.Sc. HONOURS IN GEOLOGY PROGRAMME

The B.Sc. Honours in Geology programme is designed to provide a strong foundational understanding of Earth's materials, processes, and history while equipping students with the analytical, technical, and field-based skills required to address contemporary challenges related to natural resources, environmental sustainability, and geohazards; by integrating theoretical knowledge with hands-on laboratory training, modern geoscience tools, and extensive fieldwork, the programme prepares graduates for advanced studies, research, and diverse career opportunities in Earth Sciences and allied sectors. The four-year structure allows for both breadth and depth, ensuring students can pursue higher education, competitive exams (like JAM, GATE, CSIR-NET), or professional careers with confidence and competence.

5. THE PROGRAMME

The four-year B.Sc. Honours in Geology programme offered under CBCS by the Department of Geology, CUTN has eight semesters, which include 65 courses in total with an overall credit of 168 to 171 for B.Sc. Hon and B.Sc. Hon with research, respectively. At the end of the first year, the student has the flexibility to slide over to any of the other three majors (Chemistry, Mathematics, or Physics) based on his/her interest and following CUTN norms. Further, an exit option can be availed at the end of the first, second, and third year, provided the student has satisfied the required credits to get a certificate, diploma, or B.Sc. degree, respectively.

6. COURSE FEATURES

The courses embrace Geology, Mathematics, Physics, and Chemistry, elective courses, language, ability enhancement, geological field visit, skill enhancement, value-added courses, apart from research methodology and online MOOC courses. In addition, internship and research project courses are included in the curriculum.

7. ELIGIBILITY AND ADMISSION

A pass in the Plus Two examination or equivalent of any recognised board in India with 60% marks for General Category, 55% marks for OBC (NCL)/EWS, and 50% marks for SC/ST/PWD candidates. The admission into the programme is done through the Common University Entrance Test (CUET) conducted by NTA (Mathematics, Chemistry, and Physics, from the CUET-UG domain subject list)

8. EXAMINATION

The assessment of a student pursuing the B.Sc. Honours Geology programme shall be based on his/her performance in the Continuous Internal Assessment (CIA) and the End Semester Examinations (ESE). For theory courses, the distribution of marks for CIA and ESE is 40% and 60%, respectively. Irrespective of the score obtained by a student in the CIA, he/she must score a minimum of 50% marks in total (out of 100) to pass a course. The practical courses are evaluated based on continuous assessment.

8.1. CONTINUOUS INTERNAL ASSESSMENT (CIA)

The 40% marks for CIA shall be based on the students' performance in the following

(i) Periodical assessment tests, and assignments (30%)

(ii) Seminar presentations, report, and attendance (10%)

8.2. END SEMESTER EXAMINATION (ESE)

The ESE for theory courses (maximum marks 60%) will be conducted by the University at the end of each semester (odd and even). The student must register for the semester examination to be eligible for registration in the following semester's examinations. To attend the examination, 75% attendance is mandatory.

8.2.1. COMMON MODEL QUESTION PAPER

The end-of-semester examination question paper comprises three sections, with a maximum of 60 marks and an allowed time of 3 hours.

SECTION A (10 X 1 = 10) Answer ALL the questions

Ten short questions, two questions from each unit. Four choices of answers in each question.

1. Unit-I
2. Unit-I
3. Unit-II
4. Unit-II
5. Unit-III
6. Unit-III
7. Unit-IV
8. Unit-IV
9. Unit-V
10. Unit-V

SECTION B (5 x 3 = 15) Answer ALL questions

Answer all the questions.

11. Unit-I
12. Unit-II
13. Unit-III
14. Unit-IV
15. Unit-V

SECTION C (5 x 7 = 35) Answer ALL the questions

Answer all questions by choosing either (a) or (b) from each question. One question from each unit.

16. Unit-I (a or b)
17. Unit-II (a or b)
18. Unit-III (a or b)
19. Unit-IV (a or b)
20. Unit-IV (a or b)

9. PRACTICAL COURSE ASSESSMENT

The assessment of practical courses will be done based on the students' performance in the laboratory, regular attendance, on-time submission of observation and record notes, and written/viva-voce examinations.

10. ATTENDANCE

In each semester, the minimum attendance for a student to be eligible to appear in the end-of-semester examination is 75% in each course. Upon failing the minimum requirement, the student shall abide by the University norms for eligibility. Attendance also accounts for 5% of the Continuous Internal Assessment (CIA) in each course.

11. INTERNSHIP

Students shall undergo one summer internship during the third year (2 credits) for a period of 1-2 months. They are encouraged to take up internships at industries/research labs/ institutes/universities (including CUTN). The evaluation of the internship would be based on external (60%, host institution) and internal (40%, Departmental) assessment.

12. B.Sc. HONOURS AND B.Sc. HONOURS WITH RESEARCH STREAMS

Under the National Education Policy (NEP) 2020, students pursuing an Undergraduate Science degree can graduate with either a B.Sc. (Honours) or B.Sc. (Honours with Research), depending on their academic performance up to the end of the sixth semester. Students who complete a minimum of 120 credits and secure a CGPA of 7.5 or above by the end of the third year are eligible to join the B.Sc. (Honours) degree with research.

Those with a CGPA of 7.5 or higher may also opt to continue into the fourth year to pursue a research project, upon successful completion of which they will be awarded a B.Sc. (Honours with Research) degree after earning a minimum of 160 credits. Students have the option to exit at the end of the first/second/third year to get a Certificate/Diploma/B.Sc. degree, respectively. The student must inform the department at the beginning of the respective even semester if he/she wish to exit. For the students opting for B.Sc. Honours with Research, the research guide shall be allotted to the students based on their research interest and academic ranking. The project report shall be submitted in the form of a dissertation at the end of the 8th semester on or before the date notified by the Department. The student shall present the research project work and shall be evaluated by the Department.

13. INTERDISCIPLINARY AND RESEARCH INTEGRATION

The curriculum is designed to enable interdisciplinary engagement, allowing students to take electives from Mathematics, Physics, Chemistry, Environmental Science, Data Science, and more. Students undertake independent research projects or internships under faculty supervision, fostering research skills and a scientific mindset that supports further studies and innovation.

14. EMPLOYABILITY AND CAREER PATHWAYS

Graduates of this programme are equipped for a wide range of academic and career opportunities:

✓ Postgraduate programmes in Geology and interdisciplinary sciences

✓ Research roles in government and private laboratories

✓ Industrial careers in Mining, Oil, Energy, and environmental sectors

✓ Teaching, and scientific positions

✓ Civil Services (UPSC and State PSC)

✓ Opportunities in entrepreneurship, quality control, and consultancy

The skill-based and research-oriented nature of the programme prepares students to adapt to changing scientific and technological landscapes.

15. ALIGNMENT WITH NEP 2020

This programme is firmly aligned with the vision of **NEP 2020**, offering:

- **Flexible and modular structure** with multiple exit/entry points
- **Emphasis on foundational, vocational, and research training**
- **Integration of ethics, environmental consciousness, and experiential learning**
- **Credit mobility** and potential for **multidisciplinary learning**

The Department of Geology, CUTN, is committed to fostering academic excellence, research innovation, and societal impact through this holistic undergraduate programme.

16. REVISION OF CURRICULUM

The Department of Geology shall revise and amend the regulations in the curriculum based on the feedback received from the stakeholders on a regular basis.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

After four years of successful completion of the program, the student will be able to

PEO1 To provide knowledge in basic and applied geology

PEO2 To develop analytical and logical aptitude amongst students to adapt quickly in the geological domain, and problem-solving ability

PEO3 To provide exposure to new technologies to the students and motivate them to take on new challenges in the earth sciences domain

PEO4 To inculcate self-learning, discipline, and leadership qualities, to introduce them to a holistic approach of working in a team according to the codes of professional practice

PEO5 High level of technical competence in research that generates, communicates, and applies new knowledge for the betterment of society

GRADUATE ATTRIBUTES FOR GEOLOGY

1. **Disciplinary Knowledge**: Content and pedagogical knowledge synchronised with the curriculum frameworks of geology and its application
2. **Communication Skills**: Possess clarity in conveying the ideas
3. **Critical Thinking**: Capacity to apply analytical skills through theory and practical classes
4. **Problem Solving**: in resolving earth related issues.
5. **Co-operation**: Appreciate collaboration and cooperation among various organisations and industries.
6. **ICT Skills**: Selecting and integrating appropriate ICT skills for professional development.
7. **Ethics**: Doing what is right to society. Apply the knowledge of geoscience to identify the societal issue, e.g., Natural hazards, natural resources, etc., and sustainable development
8. **Reasoning**: Ability to interpret and draw conclusions from qualitative/quantitative data with open-mindedness
9. **Creativity**: Ability to produce new ideas
10. **Societal and Environmental Concern**: Performing an act or solving a problem with respect to societal and environmental concerns
11. **Lifelong Learning**: Understands the need for learning and practices it throughout life

PEO to Mission Statement Mapping

	PEO1	PEO2	PEO3	PEO4	PEO5
M1	✓	✓	✓	✓	✓
M2	✓	✓	✓	✓	✓
M3	✓	✓	✓	✓	✓
M4	✓	✓	✓	✓	✓
M5	✓	✓	✓	✓	✓

B.Sc. Honours / B.Sc. Honours with Research in Geology
PROGRAMME OUTCOMES

On the successful completion of the program, the student will be able to (for all courses)

PO1 Become professional in the subject of Geology and apply the principles of the same to the needs of the Employer / Institution /Enterprise/ Society

PO2 Gain Analytical skills in the field/area of Geology

PO3 Able to identify, analyze, interpret geological data in multiple perspectives

PO4 Able to use skills and modern technical tools in the field of Geology

PO5 Able to work as an individual and as teams with cross-culture perspective with a potentially become leader with practical communication skills

PO6 Identify, formulate, research literature, and analyze complex problems reaching substantiated conclusions

Mapping of POs with PEOs

	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	✓	✓	✓	✓	✓	✓
PEO2	✓	✓	✓	✓	✓	✓
PEO3	✓	✓	✓	✓	✓	✓
PEO4	✓	✓	✓	✓	✓	✓
PEO5	✓	✓	✓	✓	✓	✓

THE COURSE STRUCTURE

This Four-Year Undergraduate Programme is structured under the Choice-Based Credit System (CBCS) and adheres to NEP 2020 guidelines:

Duration: 4 years (8 semesters); Total Credits: 171 **Curriculum Components**: - Core Geology Courses (CC, CCP) - Discipline-Specific Electives (DSE) - Allied Courses (Minor) - Ability Enhancement Courses (AECC) - Skill Enhancement Courses (SEC) - Value Added Courses (VAC) - Interdisciplinary/Open Electives (OE) - Internship (INT) - Research/Project Work in the final year (PROJ) - Extension Activities (EXT)	**Exit Options (as per NEP 2020):** 1. Certificate after 1 year 2. Diploma after 2 years 3. B.Sc. Degree after 3 years 4. B.Sc. (Hon) after 4 years 5. B.Sc. (Hon) with Research) after 4 years

FIRST YEAR

SEMESTER – I

Sl. No.	Course Code	Course Title	Type	Credit	Hours /Week	Marks	
						Int	Ext
1	GLY5011	Introduction to Geology$^{\alpha}$	CC	3	3	40	60
2	GLY5012	Geology (Practical-1)$^{\alpha}$	CCP	2	4	100	
3		Mathematics (or) Physics	Minor	3	3	40	60
4		Subject Practical-I (Mathematics (or) Physics)	Minor	2	4	100	
5	GLYOEU1	Open elective$^{\beta}$	OE	3	3	40	60
6		Tamil/English/Hindi/French	AECC	3	3	40	60
7		Skill Enhancement Course	SEC	2	2	40	60
8		Value Added Course	VAC	3	3	40	60
Total				**21**	**25***		

SEMESTER – II

Sl. No.	Course Code	Course Title	Type	Credit	Hours / Week	Marks	
						Int	Ext
1		Mathematics (or) Physics	Minor	3	3	40	60
2		Subject-specific Practical-II (Mathematics (or) Physics)	Minor	2	4	100	
3		General Physics (or) Mathematics	Minor	3	3	40	60
4		Subject Practical-II (Mathematics (or) Physics)	Minor	2	4	100	
5	GLYOEU2	Open elective$^{\beta}$	OE	3	3	40	60
6		Tamil/English/Hindi/French	AEC C	3	3	40	60
7		Skill Enhancement Course	SEC	2	2	40	60
8		Value Added Course	VAC	3	3	40	60
Total				**21**	**25**		
Cumulative Total				**42**			
9		Skill Development of the Youths and their livelihood (NPTEL) **	VOC	4	4	100	
Cumulative Total				**46****			

$^{\alpha}$ offered as a minor course in odd/even semesters to science departments UG Ist year students
$^{\beta}$Open elective course for other departments
*Additionally, students should attend the extension activities
**This course is for Certificate Programme students

SECOND YEAR

SEMESTER – III

Sl. No.	Course Code	Course Title	Type	Credit	Hours / Week	Marks	
						Int	Ext
1	GLY5031	Crystallography and Mineralogy	CC	3	3	40	60
2	GLY5032	Crystallography and Mineralogy (Practical)	CCP	2	4	100	
3		Differential Equations and Integral Transforms	Minor	3	3	40	60
4		General Chemistry	Minor	3	3	40	60
5	GLYOEU3	Open elective$^{\beta}$	OE	3	3	40	60
6		Tamil/English/Hindi/French	AECC	3	3	40	60
7	GLYSE01	Survey Techniques (Skill Enhancement Course)	SEC	2	2	40	60
8		Yoga	VAC	2	2	40	60
Total				**21**	**25**		
Cumulative Total				**63**			

SEMESTER – IV

Sl. No.	Course Code	Course Title	Type	Credit	Hours / Week	Marks	
						Int	Ext
1	GLY5041	Igneous and Metamorphic Petrology	CC	3	3	40	60
2	GLY5042	Sedimentary Petrology	CC	3	3	40	60
3	GLY5043	Structural Geology	CC	3	3	40	60
4	GLY5044	Igneous and Metamorphic Petrology (Practical)	CCP	2	4	100	
5	GLY5045	Sedimentary Petrology (Practical)	CCP	2	4	100	
6	GLY5046	Structural Geology (Practical)	CCP	2	4	100	
7	GLYSE02	Geological Field Mapping	SEC	3	$	100	
8		Tamil/English/Hindi/French	AECC	3	3	40	60
9		Extension Activity*	EXT	1	$$		
Total				**21/22***	**24$**		
Cumulative Total				**84**			
10		Skill Development of the Youths and their livelihood (NPTEL)$^{\#}$	VOC	4	4	100	
Cumulative Total				**88**			

$^{\beta}$Open elective course for other departments
*Additionally, students should attend the extension activities
$$ Extension Activities NSS/NCC/Others as per the CUTN norms (Non-credit)

[#] This course is for Diploma Programme students
[$] Additional field visit hours including field theory, and Extension Activities

THIRD YEAR

SEMESTER – V

Sl. No.	Course Code	Course Title	Type	Credit	Hours / Week	Marks	
						Int	Ext
1	GLY5051	Palaeontology	CC	3	3	40	60
2	GLY5052	Economic Geology	CC	3	3	40	60
3	GLY5053	Introduction to Geodesy	CC	3	3	40	60
4	GLY5054	Hydrogeology, Remote Sensing, and GIS	CC	3	3	40	60
5	GLY5055	Natural Hazards	CC	3	3	40	60
6	GLY5056	Palaeontology (Practical)	CCP	2	4	100	
7	GLY5057	Hydrogeology and Remote Sensing (Practical)	CCP	2	4	100	
8	GLYEC01	Sample Preparation Techniques in Geology-I	DSE	2	4	100	
9	GLYON^^	MOOC-1***	DSE	3	3	40	60
Total				**24**	**30**		
Cumulative Total				**108**			
***Students are advised to take MOOC course in their III/IV semester							

SEMESTER – VI

Sl. No.	Course Code	Course Title	Type	Credit	Hours / Week	Marks	
						Int	Ext
1	GLY5061	Engineering and Mining Geology	CC	3	3	40	60
2	GLY5062	Oceanography and Climatology	CC	3	3	40	60
3	GLY5063	Coal and Petroleum Geology	CC	3	3	40	60
4	GLY5064	Indian Stratigraphy	CC	3	3	40	60
5	GLY5065	Geological Field Visit	CC	4	4[$]	100	
6	GLYEC02	Fundamentals of Geophysics	DSE	3	3	40	60
7	GLYEC03	Sample Preparation Techniques in Geology-II	DSE	2	4	100	
8	GLYIN01	Internship ◆	Int	2	-	100	
Total				**23**	**23**		
Cumulative Total				**131**			
◆ - During the semester vacation of II/III/IV/V							

Students can exit after three years with a B.Sc. Geology degree (with 131 credits)

Students who wish to continue for a fourth year will receive either a B.Sc. Honours / Honours with research degree based on their total CGPA as follows

For B.Sc. Honours with research degree, the students shall score more than 7.5 CGPA

FOURTH YEAR

SEMESTER – VII

Sl. No.	Course Code	Course Title	Type	Credit	Hours / Week	Marks	
						Int	Ext
1	GLY5071	Structural Geology and Tectonics	CC	3	3	40	60
2	GLY5072	Geochemistry and Isotope Geology	CC	4	4	40	60
3	GLY5073	Ore Geology	CC	3	3	40	60
4	GLY5074	Mining Geology	CC	3	3	40	60
5	GLY5075	Engineering Geology	CC	3	3	40	60
6	GLY5076	Geochemistry and Ore Geology (Practical)	CCP	2	4	100	
7	GLY5077	Structural Geology and Tectonics (Practical)	CCP	2	4	100	
8	GLY5078	Mining and Engineering Geology (Practical)	CCP	2	4	100	
Total				**22**	**28**		
Cumulative Total				**153**			

SEMESTER – VIII

For B.Sc. Honours Degree

Sl. No.	Course Code	Course Title	Type	Credit	Hours / Week	Marks	
						Int	Ext
1	GLY5081	Research Project	PROJ	6	15	40	60
2	GLY5082	Research Methodology and Publication Ethics	CC	4	4	40	60
3	GLY5083	Global Climate Change	CC	4	4	40	60
4	GLYON^^	MOOC-2##	DSE	3	3	100	
5	GLYON^^	MOOC-3##	DSE	3	3	100	
Total				**20**	**29**		
Overall Total Credits				**173**			
	For B.Sc. Honours with Research Degree						
1	GLY5084	Research Project	PROJ	12	24	100	
2	GLY5082	Research Methodology and Publication Ethics	CC	4	4	40	60
3	GLYEC04	Global Climate Change	DSE	4	4	40	60

Total	**20**	**32**	
Overall Total Credits	**173**		
##Students are advised to take MOOC course in their VI/VII semester			

SEMESTER - I				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5011	**Introduction to Geology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	explain Earth's origin, internal structure, plate tectonics, and geological time	Understand
CO2	identify landforms produced by weathering and geological agents	Analyze
CO3	explain the tools that geologists use to identify and classify minerals and rocks	Apply

b. Syllabus

Units	Content	Hrs.
I	Definition and scope of geology, various branches of geology; origin of the Universe; Big Bang Theory; Origin of the Solar System and its planets; Nebular hypothesis; Classification of planets -The terrestrial and Jovian planets; Meteorites and Asteroids. Mechanical and chemical layering of the Earth.	9
II	Concept of Geological time- Relative age and absolute age; principles used to determine the relative age; Geological time scale; isotope dating; Age of the Earth	9
III	Concept of plate tectonics, sea-floor spreading and continental drift; Different types of plate boundaries- Convergent boundary, divergent boundary and transform faults; Distribution of Earthquake and volcanoes and their relationship with plate boundaries.	9
IV	Introduction to Geomorphology; Weathering: physical, chemical, and biological weathering; Geological agents and landforms: Fluvial processes and river landforms, Glacial processes and glacial landforms, Aeolian processes and desert landforms, Coastal processes and coastal landforms	9
V	Element distribution in the Earth's crust, definition of minerals, physical properties of minerals, classification of minerals, industrial applications of minerals, Classification of rocks: igneous, sedimentary, metamorphic; Rock cycle and its significance	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Grotzinger, J., & Jordan, T. H. (2010). Understanding earth. Macmillan.
2. Plummer, C. C., Carlson, D., & Hammersley, L. (2016). Physical geology. McGraw-Hill/Education.
3. Skinner, B. J., & Porter, S. C. (1995). The blue planet: an introduction to earth system science. New York: John Wiley.

Reference Books

1. Marshak, S. (2011). Earth: Portrait of a planet: Fourth international student edition. WW Norton & Company.
2. Klein, C., & Philpotts, A. R. (2013). Earth materials: introduction to mineralogy and petrology. Cambridge University Press.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓		✓	✓
CO2	✓		✓	✓	✓	✓
CO3		✓	✓	✓		✓

SEMESTER – I				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5012	**Geology (Practical-1)**		**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	read maps and explain signs and symbols	Apply
CO2	use magnetic compass; identify relief forms based on contour pattern	Analyze

b. Syllabus

Units	Content	Hrs.
I	Basics of maps: Definition and types of maps: topographic, thematic, geological and drainage maps; Use of different types of maps; Map elements: title, legend, north arrow, scale, grid, marginal information, index; and map accuracy. Geographic coordinates: latitude, longitude, locating points using coordinates and grid references.	12
II	Toposheets reading: scale series, symbols and conventional signs (roads, settlements, vegetation, drainage, boundaries, benchmarks, spot heights); Numbering scheme for Indian topographic maps: million sheet, degree sheet, quadrant sheet, and toposheet.	12
III	Map scale: graphical, verbal and representative fraction; conversion between scales; concept of large-scale vs small-scale maps with simple numerical problems relating map and ground distance; Measurement of distance and area on maps: use of scale, dividers, string method, grid counting; pace approximation and field estimation of distance.	12
IV	Contours: definition, contour interval, index contours; rules of contouring; interpretation of relief forms based on contour pattern (ridges, valleys, spurs, escarpments, passes, conical hills, plains); Geological maps: Components of geological map; Basic structural symbols: strike and dip notation, fold axes;	12
V	Magnetic compass: Introduction to magnetic compass, its components; Field use of maps: orienting toposheets in the field, Simple interpretation of geological maps: identifying outcrop patterns of horizontal, and dipping beds; construction of structural contour, preparation of simple geological maps with three-point problems.	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Text Books

1. Robinson, A., Morrison, J.L., Muehrcke, P.C., Kimerling, A.J. and Guptill, S.C. (2011). Elements of Cartography. 6th edition. New York: Wiley.
2. Singh, G. (2004). Map Work and Practical Geography. Delhi: Vikas Publication House.
3. Singh, R.L. and Singh, R.P.B. (2003). Elements of Practical Geography. New Delhi: Kalyani Publishers.
4. Billings, M. P., (1987), Structural Geology, 4th edition, Prentice-Hall.
5. Lisle, R.J., (2004), Geological Structures and Maps: A Practical Guide, Third Edition. Elsevier
6. Edgar W. Spencer, (2018). Geologic Maps: A Practical Guide to Preparation and Interpretation, Third Edition, Waveland Press, Inc.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	
CO2	✓	✓		✓	✓	✓

SEMESTER – III				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5031	**Crystallography and Mineralogy**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the basics of crystal chemistry and crystal structure, and understand the concept of symmetry elements in crystallography	Understand
CO2	describe the chemical composition, crystal structure, and classification of major rock-forming and ore-forming mineral groups.	Analyze
CO3	apply petrological microscopy techniques using plane-polarized and cross-polarized light to identify minerals based on their characteristic optical properties.	Apply

b. Syllabus

Units	Content	Hrs.
I	Elementary ideas about crystal morphology in relation to internal structures. Unit cells and Bravais lattices. Stacking sequences and close-packed structures (Cubic Closed Packing; Hexagonal Closed Packing). Crystal Impurity and Defects – Point Defect; Line Defect; Edge Dislocation; Screw Dislocations	9
II	Miller-Bravais indices; Classification of crystals into six systems and 32-point groups; Crystal symmetry and Representation of symmetry on Stereograms; Stereographic projections of symmetry elements and crystallographic forms; Hermann-Mauguin Notation	9
III	Definition of Mineral and Mineraloid; physical properties of minerals- form, habit, color, luster, streak, cleavage, fracture, hardness, specific gravity, electrical, magnetic and radioactive properties of minerals.	9
IV	Classification of minerals. Rock forming and ore forming minerals. Silicates- Structure and classification of silicate minerals. Physical, chemical and optical properties of the following mineral groups: olivine, garnet, pyroxene amphibole, mica, feldspar, feldspathoids and quartz.	9
V	Nature of light, Ordinary and polarized light, polarization of light, refractive index, critical angle and total internal reflection. Double refraction, construction of Nicol prism. Isotropic and anisotropic minerals. Petrological microscope parts and their functions; Optical properties of minerals under plane polarized light – color, pleochroism, crystal habit, relief, and cleavage; Optical properties of minerals under crossed polarized light- interference color, birefringence and twinning; Basic description of indicatrix;	9

	conoscopic observation and interference figures for uniaxial and biaxial minerals; Optic sign determination.	

Tasks and Assignments:
Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Nesse, W. D., (2009), Introduction to optical mineralogy. Oxford University Press, New York, USA
2. Nesse, W.D., (2020), Introduction to Mineralogy. Oxford University Press, New York, USA
3. Perkins, D., (2015), Mineralogy. Pearson Education India.
4. Rutley, F., (2012). Rutley's elements of mineralogy. Springer Science & Business Media.

Reference Books

1. Deer, W., Howie, R. A., & Zussman, J., (1992), An introduction to the rock-forming minerals (p. 696). Longman.
2. Klein, C., Dutrow, B., Dana, J. D., & Klein, C., (2002), Manual of mineral science (p. 641). New York: Wiley.
3. Okrusch, M., & Frimmel, H. E. (2020). Mineralogy: An introduction to minerals, rocks, and mineral deposits. Springer Nature.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓			✓
CO2	✓	✓	✓	✓	✓	✓
CO3	✓		✓	✓		✓

SEMESTER - III				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5032	**Crystallography and Mineralogy (Practical)**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	identify the common minerals based on their diagnostic physical and optical properties.	Skill
CO2	understand the crystallography symmetry elements and identify crystallographic forms	Apply

b. Syllabus

Units	Content	Hrs.
I	Goniometer and its use in measuring the interfacial angle of crystals and calculation of the axial ratio, Miller index, Weiss parameter	12
II	Representation of symmetry elements of crystals belonging to the 32 classes of symmetry and study of their stereograms	12
III	Megascopic identification of common rock forming silicates, carbonates, oxides minerals in hand specimens.	12
IV	Megascopic identification of common sulfides, sulfates, halite, phosphates and native minerals in hand specimens.	12
V	Study of optical properties of minerals under both open and crossed nicols; Identification of common rock-forming minerals.	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Text Books

1. Klein, C., Dutrow, B., Dana, J. D., & Klein, C., (2002), Manual of mineral science (p. 641). New York: Wiley.
2. Kleinn, C. & Hurlbut, C. S. (1993), Manual of Mineralogy. John Wiley & Sons, INC
1. Nesse, W.D., (2020), Introduction to Mineralogy. Oxford University Press, New York, USA
2. Perkins, D., (2015), Mineralogy. Pearson Education India.

Reference Books

1. Kerr, P. F. (1977). Optical mineralogy. McGraw-Hill Inc.

2. MacKenzie, W. S., Adams, A. E., & Brodie, K. H., (2017), Rocks and Minerals in Thin Section: A Colour Atlas. CRC Press.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓		✓
CO2	✓	✓	✓		✓	✓

SEMESTER - III				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLYSE01	**Survey Techniques (Skill Enhancement Course)**	**1**	**1**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	uses of the various survey techniques and tools in the geological survey	Analyze
CO2	use of computer-based applications and digital survey techniques in the survey.	Apply

b. Syllabus

Units	Content	Hrs.
I	Basic Principles of Survey, History of Survey, Survey of India (SOI) products and its applications; survey and scale variations, error estimation; length and area estimation from toposheet.	6
II	Geological survey methods: surface (identification different rock types, lithology boundary mapping, natural boundary) and subsurface methods.	6
III	Chain survey, plain table survey, campus survey, angle measurement, triangulations, leveling, determination of position, and topographic mapping.	12
IV	Digital survey techniques: Electronic Distance Measuring Instrument (EDMI), Drone - Digital Elevation Model (DEM), Digital Terrain Model (DTM),	12
V	Introduction to GNSS, GPS mapping, waypoint and its applications, GPS data down load and computer applications using open source	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Text Books

1. Duggal S., (2013). Surveying., McGraw Hill Education (India).
2. Sateesh Gopi, R., Sathishkumar, Madu, N., (2007). Advanced Surveying, Pearson
3. Merriam D.F., (2000), Computer Methods in the Geosciences, Elsevier.

4. Richard J. Lisle, Peter Brabham, John W. Barnes (2011). Basic Geological Mapping, 5th Edition. ISBN: 978-0-470-68634-8. Wiley.
5. Aerospace Corporation, (2003). GPS Primer: A Student Guide to the Global Positioning System. Los Angeles, USA. Available at: http://www.aero.org/education/primers/gps/GPS-Primer.pdf

Reference Books

1. Records of the Geological Survey of India (https://archive.org/details/dli.ministry.19665/E15066_Records_Memoirs_Of_The_Geological_Survey_Of_India/)
2. John Barnes., (1984). Basic Geological Mapping. Open University Press, Milton Keynes.
3. Feng, Y (2003), Combined Galileo and GPS: A Technical Perspective. Journal of Global Positioning Systems, 2 (1): 67-72.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓			✓	✓	
CO2	✓	✓	✓	✓	✓	✓

SEMESTER - IV				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5041	**Igneous and Metamorphic Petrology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the processes of magma generation, crystallization mechanisms, and magmatic differentiation to explain the compositional and mineralogical diversity observed in igneous rocks.	Understand
CO2	identify and interpret diagnostic textural and structural features in igneous rocks as indicators of their thermal history, crystallization environment, and association with specific tectonic regimes.	Apply
CO3	explain the mechanism of metamorphism and the role of pressure and temperature in the formation of metamorphic rocks.	Analyze

b. Syllabus

Units	Content	Hrs.
I	Rock-definition, types, rock cycle; partial melting and magma generation; cooling and crystallization of magma- volcanic and plutonic rock; Bowen's reaction series; Forms of intrusive igneous rocks - Concordant forms and Discordant forms; Forms of extrusive igneous rocks; Igneous structures; The common igneous Textures: definition and description.	9
II	Diversity of igneous rocks- magmatic differentiation process, fractional crystallization, liquid immiscibility and assimilation/contamination; Gibb's Phase rule and concept of phase diagrams - Simple binary system with no solid solution- Di-An system, binary system with complete solid solution- Ab-An system, binary peritectic system- Fo-Qtz system, Ternary eutectic system- Di-An-Fo system.	9
III	Classification of igneous rocks based on field relations, texture, mineralogy and chemistry. Petrographic characteristics, occurrence, origin and tectonic environments of important igneous rocks.	9
IV	Introduction to metamorphism: Concept, agents, and types of metamorphism. Classification of metamorphic rocks. Texture and structure of metamorphic rocks	9
V	Concept of metamorphic zone, index minerals, isograds and grades. Metamorphic facies of contact and regional metamorphism. Thermodynamic principles of metamorphic reactions. Metamorphism and plate tectonics.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Anthony R. Philpotts & Ague, J. J., (2009), Principles of Igneous and Metamorphic Petrology. Cambridge.
2. Best, M. G., (2002). Igneous and metamorphic petrology. John Wiley & Sons.
3. Philpotts, A.R., (2003), Petrography of Igneous and metamorphic rocks. Waveland Pr Inc.
4. Winter, J. D., (2001), Igneous and Metamorphic Petrology. Prentice Hall.

Reference Books

1. Gill, R., (2010). Igneous rocks and processes: a practical guide. John Wiley & Sons.
2. Sen, G., (2013). Petrology: Principles and practice. Springer Science & Business Media.
3. Wilson, M., (Ed.). (1989). Igneous petrogenesis. Dordrecht: Springer Netherlands.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓			✓
CO2		✓	✓	✓		✓
CO3	✓		✓	✓	✓	✓

SEMESTER - IV				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5042	**Sedimentary Petrology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	**Level**
CO1	understand the fundamental processes of weathering, transportation, deposition, and diagenesis within the sedimentary rock cycle.	Understand
CO2	classify sedimentary rocks using genetic, textural, and compositional criteria, and interpret key sedimentary textures and structures.	Analyze
CO3	identify and describe major sedimentary rocks and evaluate their key petrological properties.	Apply

b. Syllabus

Units	**Content**	**Hrs.**
I	Definition, scope, and importance of sedimentary petrology, rock cycle with emphasis on sedimentary processes, Classification of sedimentary rocks: g enetic classification: clastic, chemical, biochemical, volcaniclastic, Textural vs. compositional classification;	9
II	Weathering processes: chemical, physical, biological; Soil formation and paleosols; Erosion and transportation by wind, water, ice, gravity; Concepts of competence, capacity, viscosity, turbulence;	9
III	Depositional mechanisms: suspension, saltation, traction; Diagenesis: compaction, cementation, recrystallization, authigenesis; Porosity and permeability	9
IV	Sedimentary Textural study: roundness, sphericity, sorting, shape; Compositional maturity vs. textural maturity; sedimentary structures: Bedding, lamination, graded bedding, cross bedding, ripple marks; Mud cracks, Biogenic structures & trace fossils	9
V	Descriptive Petrological study of the siliciclastic rocks - conglomerate, breccia, quartz, mudrocks / shale; Descriptive Petrological study of the carbonate rocks limestones,	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Boggs, S., (1995), Principles of Sedimentology and Stratigraphy. Print ice Hall, New Jersey.
2. Friedman, G.M and Sanders, J.L., (1978). Principles of Sedimentology, John Wiley.
3. Nichols, G., (1999), Sedimentology and Stratigraphy. Wiley-Blackwell.
4. Prothero, D. R., (2013), Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy (3rd Ed.). W. H. Freeman.
5. Tucker, M.E., (2006), Sedimentary Petrology. Blackwell. Boggs, Sam, Jr. Petrology of Sedimentary Rocks. 2nd ed., Cambridge University Press, 2012.

Reference Books

1. Allen, P.A., (1997), Earth Surface Processes. Blackwell.
2. Collinson, J.D. & Thompson, D.B., (1988), Sedimentary Structures. Unwin-Hyman, London.
3. Leeder, M., (2009), Sedimentology and Sedimentary Basins: from Turbulence to
a. Tectonics. John Wiley & Sons.
4. Lindholm, R.C., (1987), A Practical Approach to Sedimentology. Allcn ane Unwin, London.
5. Reading, H.G., (2009), Sedimentary Environments: Processes, Facies and Stratigraphy. John Wiley & Sons.
6. Sengupta, Saibal. Introduction to Sedimentology. CBS Publishers, 2012.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓				
CO2		✓	✓	✓		
CO3	✓	✓	✓	✓	✓	✓

SEMESTER – IV				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5043	**Structural Geology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	describe and classify primary and secondary geological structures in the field and on maps.	Understand
CO2	explain concepts of stress, strain and deformation behaviour of rocks.	Analyze
CO3	describe the nomenclature and classification of fold and fault	Apply

b. Syllabus

Units	Content	Hrs.
I	Introduction to Structural Geology: basics of rock deformation and development of structures; primary and secondary structures; planar and linear structures; concept of dip, strike, plunge and pitch; true vs apparent dip Outcrop patterns, effect of topography on outcrops; outlier and inlier.	9
II	Concept of Stress and strain: normal and shear stress; homogeneous and inhomogeneous strain, rotational and irrotational strain in rocks; strain ellipsoid.	9
III	Fold: Nomenclature, components of fold (hinge, limb, axial plane, axial trace, plunge, interlimb angle); geometric and genetic classification of fold; Recognition of folds in field and map; recognition of domes, basins, anticlines and synclines from outcrop patterns. Faults: terminology and classification of faults.	9
IV	Joints: Definition and types (tension, shear, columnar, exfoliation), joint sets and patterns, geological significance of joints; introduction to shear zones, origin and types (brittle and ductile).	9
V	Plates and plate boundaries; principles of plate tectonics; continental drift, seafloor spreading; orogeny and epeirogeny.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Billings, M. P., (1987), Structural Geology, 4th edition, Prentice-Hall.
2. Fossen, H., (2010), Structural Geology. Cambridge University Press.
3. Ghosh, S.K., (1993), Structural Geology: Fundamentals and Modern Developments. Pergamon Press.
4. Gokhale, N. W. (2019): Theory of Structural Geology. CBS Publishers.
5. Ragan, D.M., (2009), Structural Geology: An Introduction to Geometrical Techniques, 4th Edition. Cambridge University Press.
6. Twiss, R.J. & Moores, E.M., (2006), Structural Geology, 2nd Edition. W. H. Freeman.

Reference Books

1. Hobbs, B.E., Means, W.D. & Williams, P.F., (1976), An outline of Structural Geology. John Wiley and Sons. New York.
2. Marshak, S. & Mitra, G., (1988), Basic Methods of Structural Geology. Printice Hall.
3. Novin, C. M. Principles of structural Geology John Willey, New York.
4. Pollard, D.D. & Fletcher, R.C., (2005), Fundamentals of Structural Geology Cambridge University Press

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓	✓		✓	✓	✓
CO3	✓	✓	✓	✓		

SEMESTER – IV				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5044	**Igneous and Metamorphic Petrology (Practical)**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	identify common igneous rocks through study of their mineralogy and texture in both hand specimen and under the microscope	Analyze
CO2	Determine the characteristic properties of igneous and metamorphic rocks for their identification and understanding on analytical tools	Apply

b. Syllabus

Units	Content	Hrs.
I	Megascopic identification of common igneous rocks – rhyolite, granite, pegmatite, syenite, trachyte, diorite, andesite, basalt, gabbro, dolerite, anorthosite, dunite, komatiite, peridotite and carbonatite.	12
II	Microscopic identification of common igneous rocks – rhyolite, granite, pegmatite, syenite, trachyte, diorite, andesite, basalt, gabbro, dolerite, anorthosite, dunite, komatiite, peridotite and carbonatite.	12
III	Plotting of the modal mineralogy of igneous rocks on the QAPF diagram and classification of igneous rocks based on the IUGS Classification scheme.	12
IV	Megascopic study and identification of metamorphic rocks (Serpentinites, Albite-Epidote-Chlorite Quartz Schist, Slate, Talc-Tremolite-Calcite quartz Schist, Gneisses, Amphibolite, Hornfels, Garnetiferous Schists, Sillimanite-Kyanite-Bearing Rocks, Granulites, Eclogite, Diopside-Forsterite Marble)	12
V	Preparation of thin sections for microscopic study. Microscopic study and mineralogical/textural characterization of metamorphic rocks	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Text Books

1. Winter, J. D., (2014). Principles of igneous and metamorphic petrology (Vol. 2). Harlow, UK: Pearson education.
2. Philpotts, A. R. (1989). Petrography of igneous and metamorphic rocks. Pearson College Division.

Reference Books

1. MacKenzie, W. S., Donaldson, C. H., & Guilford, C., (1982), Atlas of igneous rocks and their textures (Vol. 148). Harlow: Longman.
2. Vernon, R. H. (2018). A practical guide to rock microstructure. Cambridge university press.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓		✓
CO2	✓	✓	✓	✓		✓

SEMESTER - IV				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5045	**Sedimentary Petrology (Practical)**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	identify, recognize, document, and interpret the major megascopic properties and textural attributes of sedimentary rocks.	Analyze
CO2	perform thin-section petrographic analysis of clastic and non-clastic sedimentary rocks, and systematically examine, analyze, and interpret the microscopic characteristics of sedimentary rocks.	Apply

b. Syllabus

Units	Content	Hrs.
I	Conduct megascopic examination of sedimentary rocks to identify primary textural attributes such as grain size, shape, sorting, roundness, composition, and color.	12
II	Recognize and describe major sedimentary structures through megascopic observation, including bedding, lamination, graded bedding, cross-bedding, ripple marks, mud cracks, and biogenic/trace structures.	12
III	Perform megascopic identification of both clastic and non-clastic sedimentary rocks, along with determination of common cementing materials such as silica, calcite, iron oxides, and clay minerals.	12
IV	Conduct microscopic examination of siliciclastic sedimentary rocks (e.g., conglomerate, breccia, sandstone—quartz arenite, arkose, lithic arenite—mudrocks/shales) using thin sections to interpret mineralogy and textures.	12
V	Perform thin-section petrographic analysis of non-clastic sedimentary rocks, including various types of limestones, allochemical and orthochemical varieties of limestones, fossiliferous limestones, and related lithologies.	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Text Books

1. Tucker, M.E., (2006), Sedimentary Petrology. Blackwell.Boggs, Sam, Jr. Petrology of Sedimentary Rocks. 2nd ed., Cambridge University Press, 2012.
2. Tucker, M.E., (1990), Carbonate Sedimentology, Blackwell Scientific Publication.

Reference Book

1. Boggs, Sam, Jr. Petrology of Sedimentary Rocks. 2nd ed., Cambridge University Press, 2012
2. Nichols, G., (1999), Sedimentology and Stratigraphy. Wiley-Blackwell.
3. Allen, P.A., (1997), Earth Surface Processes. Blackwell.
4. Collinson, J.D. & Thompson, D.B., (1988), Sedimentary Structures. Unwin-Hyman, London.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓			
CO2		✓	✓	✓	✓	✓

SEMESTER –VI				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5046	**Structural Geology (Practical)**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	use stereographic projections to plot planar and linear structural data	Understand
CO2	prepare geological maps and solve three-point problems	Apply

b. Syllabus

Units	Content	Hrs.
I	Handling of field instruments: use of compass (brunton and clinometer) for measuring dip, strike, plunge and trend; recording of structural data in the field.	12
II	Basic elements of geological maps; Contour maps and their interpretation; construction of map with three points, determination of attitude of beds (dip and strike), preparation of cross sections, thickness and order of superposition.	12
III	Introduction to stereographic projections; plotting of planar (bedding plane, foliation plane, axial plane) and linear (lineation, fold axis).	12
IV	Preparation of block diagrams and sketches showing simple fold geometries and terminology (hinge, limb, axial plane, interlimb angle, plunge) and fault.	12
V	Rule of 'V'; outcrop patterns of different structures; tabulation and plotting of structural data;	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Text Books

1. Gokhale, N. W.: Theory of Structural Geology. CBS Publishers.
2. Ragan, D.M., (2009), Structural Geology: An Introduction to Geometrical Techniques, 4th Edition. Cambridge University Press.

3. Twiss, R.J. & Moores, E.M., (2006), Structural Geology, 2nd Edition. W. H. Freeman.

Reference Books

1. Lisle, R.J., (2004), Geological Structures and Maps: A Practical Guide, 3rd Edition. Elsevier.
2. Marshak, S. & Mitra, G., (1988), Basic Methods of Structural Geology. Printice Hall.
3. Novin, C. M. Principles of structural Geology John Willey, New York.
4. Pollard, D.D. & Fletcher, R.C., (2005), Fundamentals of Structural Geology Cambridge University Press

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓	✓		✓	✓	✓
CO3	✓	✓	✓	✓		

SEMESTER - IV				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLYSE02	**Geological Field Mapping**	**-**	**3**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	obtain the knowledge in the geological formation and familiarity in rock identification	Apply
CO2	classify the various rock types and its origin	Analyze
CO3	prepare geological field report	Create

b. Syllabus

Units	Content	Hrs.
I	Reading of Topomap (Toposheet), Open Series Map (OSM), National Map Policy (NMP) 2005, Coordinate System - latitude & longitude, Projection system, Global zoning and Toposheet numbering, toposheet index reading, contour interpreting	**24**
II	Field Study – Equipment and Supplies: General, Geological Hammers, Pocket and Hand Lenses, Hydrochloric Acid, Streak Plate, Pocket Magnet, Pocket Knife, Measuring Tapes and Scales, Haversack or Rucksack, Mohs Scale of Hardness, Cold Chisel, Protractors, Pocket Calculator, Cameras, Care and Upkeep of Instruments.	**24**
III	The compass and Clinometer: The compass and its uses- Dip of the compass needle - Magnetic declination - Clinometer: Bearing and Reading directions - Measuring altitudes - Handling of the compass.	**24**
IV	Field Study – Survey, contact zone and lithological mapping, area estimation, different lithological unit identification, exposing to various geological field including Archean to recent formations including mapping and rock or fossil sample collection	**24**
V	Reports and presentation – Report consist of the Unit-I to Unit-IV and they must prepare and present it neatly; both should contain the information like geology, stratigraphy, toposheet number, field photograph and samples.	**24**
Tasks and Assignments: Each student is required to undergo the following:		

- Assignments
- Field reports
- Seminars
- Viva-voce

Text Books

1. Barnes, J. W., (2004), Basic Geological Mapping. John Wiley & Sons Inc., New Delhi,
2. Coe, A. L., (2010), Geological Field Techniques. Open University Press, Milton Keynes, UK,
3. Gokhale, N.W., (2001), A Guide to Field Geology. CBS Publishers, New Delhi,
4. Mathur, S. M., (2001), Guide to Field Geology. Prentice Hall India. New Delhi.

Reference Books

1. Compton, R. R., (1985), Geology in the Field, John Wiley & Sons Inc., New Delhi.
2. Freeman, T., (1999), Procedures in Field Geology. John Wiley & Sons Inc., New Delhi.
3. Lahee, F, (1987), Field Geology, CBS Publishers, New Delhi.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓

SEMESTER - V				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5051	**Palaeontology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the principles of palaeontology, fossilization processes, species evolution, and major evolutionary trends through geological time.	Understand
CO2	analyze fossil assemblages, morphological features, and palaeoecological data to interpret evolutionary trends, adaptive features, and biostratigraphic significance.	Analyze
CO3	apply techniques for fossil identification, description, classification, and documentation of invertebrate, vertebrate, plant, and microfossils in laboratory and field settings.	Apply

b. Syllabus

Units	Content	Hrs.
I	Introduction to palaeontology. Introduction to fossils: definition of fossils, fossilization processes (taphonomy), taphonomic attributes and their implications. Preliminary ideas on the origin of life. Species and speciation, natural selection, and major evolutionary trends through geological time. Modes of fossil preservation and fossil sampling techniques.	9
II	Methods of describing and naming fossils; code of nomenclature. Morphological characters, systematic positions, evolutionary trends, and geological significance of major invertebrate groups, with emphasis on their palaeoecology, life habits, adaptive features, and biostratigraphic significance.	9
III	Origin of vertebrates and major steps in vertebrate evolution. Origin, diversity, and extinction of dinosaurs. Evolution of the horse. Human evolution. Introduction to Palaeobotany, including Gondwana plant fossils, gymnosperms, pteridophytes, and early land plants.	9
IV	Classification, morphology, and applications of major microfossil groups such as foraminifera, radiolaria, ostracods, spores, and pollen. Important fossiliferous horizons of India. Societal importance of fossils, the implications of microfossils in hydrocarbon exploration.	9
V	Applications of fossils: principles and methods of paleoecology; applications of fossils in the study of paleoecology, paleobiogeography, and paleoclimate. Role of fossils in palaeoenvironmental reconstructions.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text books

1. Clarksons, E.N.K., (1998), Invertebrate Paleontology and Evolution, Allen and Unwin, London.
2. Haq B. U. and Boersma A., (1998), Introduction to Marine Micropaleontology, Elsevier.
3. Prothero, D.R., (2004), Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill.
4. Raup, D.M. & Stanley, S.M., (1985), Principles of Paleontology, CBS Publication
5. Armstrong, H. A. & Brasier, M. D. (2005). Microfossils. Blackwell Publishing.

Reference books

1.Saraswati, P. K. & Srinivasan M. S., (2016), Micropaleontology: Principles and Applications, Springer.
2. Smith, A.B., (1994), Systematics and Fossil Record – Documenting Evolutionary Patterns, Blackwell.
3. Strean, C.W. & Carroll, R.L., (1989), Paleontology – the record of life, John Wiley.
4. Tolmazin, D., (1985), Elements of Dyanamic Oceanography, Allen and Unwin
5. Benton, M. J. (2009). Vertebrate Paleontology. John Wiley & Sons.
6. Colbert, E. H., Morales, M., & Minkoff, E. C. (1991). Colbert's Evolution of the Vertebrates. John Wiley & Sons.
7. Benton, M. J., & Harper, D. A. T. (2016). Introduction to Palaeobiology and the Fossil Record. Wiley-Blackwell.
8. Jones, R. W. (2011). Applications of Palaeontology: Techniques and Case Studies. Wiley-Blackwell.
9. Shukla, A. C., & Misra, S. P. (1975). Essentials of Paleobotany. Vikas Publishing House.
10. Brasier, M. D. (2009). Darwin's Lost World: The Hidden History of Animal Life. Oxford University Press.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2		✓	✓			✓
CO3	✓			✓	✓	

SEMESTER - V				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5052	**Economic Geology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	explain the concepts, classification, and properties of ore minerals and their ore–gangue relationships.	Understand
CO2	analyze structural, textural, and genetic features of ore minerals and deposits, and interpret ore-forming processes.	Analyze
CO3	evaluate the occurrence, geological settings, and economic significance of mineral deposits.	Apply

b. Syllabus

Units	Content	Hrs.
I	Introduction to ore geology, its scope, and classification of metallic, non-metallic, and industrial minerals, including ore, proto-ore, and gangue, with their physical and optical properties.	9
II	Structural and textural features of ore minerals, grain relationships, textures, replacement and deformation textures, and classification principles of mineral deposits.	9
III	Magmatic and hydrothermal ore-forming processes, including early and late magmatic stages, hydrothermal activity, nature, origin, physicochemical controls of fluids, and fluid–rock interactions.	9
IV	Study of metamorphic ore formation through remobilization, recrystallization, and mineral transformations, and sedimentary ore formation via allochthonous, autochthonous, and residual processes.	9
V	Study of the Physical and chemical properties, occurrence, geological settings, and industrial significance of major metallic and non-metallic mineral deposits of India.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Bateman, Arthur M. *Economic Mineral Deposits*. 3rd ed., Wiley, 1973.
2. Deb, M. *Mineral Deposits of India*. Allied Publishers, 1990.
3. Evans, A. M. *Ore Geology and Industrial Minerals*. 4th ed., Blackwell Publishing, 2013.
4. Guilbert, John M., and Charles F. Park. *The Geology of Ore Deposits*. 2nd ed., Waveland Press, 2007.
5. Moon, C. J., Whateley, M. K. G., and Evans, A. M. *Introduction to Mineral Exploration*. 2nd ed., Wiley-Blackwell, 2006.

Reference Books

1. Craig, J. R., and David J. Vaughan. *Ore Microscopy and Ore Petrography*. 2nd ed., Wiley, 1994.
2. Krishnamurthy, R. V., and P. S. Rao. *Economic Geology of India*. Macmillan India, 1989.
3. Mishra, R. K. *Ore Deposits of India: Geological and Economic Aspects*. New Age International, 2002.
4. Phillips, G. N., and W. L. Griffen. *Ore Deposits: A Study in Geochemistry, Mineralogy, and Genesis*. 2nd ed., Elsevier, 2012.
5. Radhakrishnan, R., and K. S. Krishnan. *Ore Geology of Indian Mineral Deposits*. Hindustan Publishing, 2001.
6. Sengupta, S. *Economic Mineral Deposits*. 2nd ed., Tata McGraw-Hill, 1993.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓	✓	✓		✓	✓
CO3	✓	✓		✓	✓	✓

SEMESTER - V				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5053	**Introduction to Geodesy**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	gain the fundamental knowledge of Geodesy	Understand
CO2	understand the geodynamics controlling the active tectonics and volcano deformation	Analyze
CO3	characterize surface motion and seismic hazards globally	Apply

b. Syllabus

Units	Content	Hrs.
I	Introduction; History of geodesy; Earth's shape: Geoid, Spheroid, Ellipsoid; Branches of Geodesy: Terrestrial geodesy – Triangulation; Trilateration; Levelling	9
II	Branches of Geodesy: Space geodesy – Global Navigation Satellite System (GNSS); Very Long Baseline Interferometry (VLBI); Satellite Laser Ranging (SLR), Gravity Recovery and Climate Experiment (GRACE), Interferometric Synthetic Aperture Radar (InSAR)	9
III	Components of GNSS – Global Positioning System (GPS), GLONASS, Galileo, BeiDou, NAVIC. Overview of GNSS – Space, control, and user segments. Reference Frames – Terrestrial reference frames (ITRF, WGS-84)	9
IV	Geodetic position and Crustal Deformation using GNSS: Crustal motion, strain estimation, Earthquake cycle (interseismic, co-seismic and post-seismic deformation) and Volcano Deformation	9
V	Application of GNSS in the Indian Sub-continent (Plate kinematics of India, Himalayan deformation, stable India plate motion) and across global active plate boundaries. Application of GNSS in the plate interior regions	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Smith, James R., Introduction to Geodesy: The History and Concepts Of Modern Geodesy, New York : Wiley, 1997
2. Ogaja, Clement A. Introduction to GNSS Geodesy. Cham, Switzerland: Springer, 2022.
3. Elliott D. Kaplan and Christopher Hegarty, Understanding GPS: Principles and Applications, 2nd Edn., Artech House Publishers, 2005
4. Seeber G., Satellite Geodesy, Walter de Gruyter · Berlin · New York 2003, 2nd edition, 2002

Reference Books

1. Condie, K. C., (1989), Plate Tectonics and Crustal Evolution. 3rd Edition. Butterworth-Heinemann Ltd.
2. Kearey P., Klepeis, K. A. & Vine, F.J., (2009), Global Tectonics 3rd Edition. Wiley-Blackwell.
3. Keller, E.A & Pinter, N., (2001), Active Tectonics. 2nd Edition. Pearson Publications

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓			✓	
CO2		✓	✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓

SEMESTER - V				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5054	**Hydrogeology, Remote Sensing, and GIS**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the hydrogeology, remote sensing and GIS	Understand
CO2	study the hydrogeology and its management	Analyze
CO3	use the remote sensing data in the geological studies	Apply

b. Syllabus

Units	Content	Hrs.
I	Concepts of Hydrogeology; hydrological cycle, evaporation, condensation, precipitation, infiltration, groundwater flow. Origin water groundwater; connate, juvenile and meteoric water. Vertical distribution of groundwater; zone of aeration, zone of saturation, capillary fringe, water table, and piezometric surface.	9
II	Definition of aquifer; aquifer types (aquitard, aquiclude, and aquifuge), confined aquifer, unconfined aquifer, semiconfined aquifer; properties of aquifer; porosity, permeability, hydraulic conductivity, storativity, and Darcy's law. Water quality; physical and chemical parameters.	9
III	Elements of EMR - wavelength regions – energy interaction in atmosphere – absorption – scattering - atmospheric windows – terrestrial interaction – spectral reflectance curves – active and passive remote sensing - Indian remote sensing centers and their activities – new satellite programs of India.	9
IV	Brief history of aerial remote sensing - principles of photography, optical axis, camera and films: types and uses; Parts of camera; frame and digital camera - analogue and digital products, photo scale and scale distortions, apparent displacement, stereoscopic view, photo interpretation elements, flight planning.	9
V	Types of satellites –orbits and swaths – scanning methods: resolution: spatial, spectral, radiometric and temporal. Applications of aerial and remote sensing data in geological studies. GIS and its data types: victor and raster data models. and applications.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Fetter., C.W., (2001). Applied Hydrogeology 4th Edition. Prentice Hall, New Jersey.
2. Todd, D.K., (1988). Groundwater Hrdrology. John Wiley & Sons
3. Wolf. P.R., (2014). Elements of Photogrammetry with Application in GIS, McGraw Hill books Co., London.
4. Moffit H.F., Edward, M.M., (1980). Photogrammetry 3rd Edition, Harper and Row Publishers, New York.
5. Lillisand T.M and R.W. Kiefer (1994). Remote Sensing and Image Interpretation (3rd edition). John Wiley & Sons, New York.
6. Sabins F.F Jr. (1987). Remote Sensing: Principles and Interpretation, W.H.Freeman & Co., New York. 5. James B. Campbell, Randolph H. Wynne, Valerie A. Thomas (2022). Introduction to Remote Sensing, Guilford Press, New York.
7. Karl Kraus (2007). Photogrammetry – Geometry from Images and Laser Scans, Walter de Gruyter, Berlin.

Reference Books

1. Raghunath, H.M., (1983). Groundwater. Wiley Eastern, Calcutta (India)
2. Pathak, B.D., (1988). Hydrogeology of India, Central Board for Irrigation and Power, Mecha Marg, New Delhi.
3. Rampal (1999). Handbook of aerial photography and interpretation, Concept Publishers
4. Shiv N. Pandey (1987). Principles and Applications of Photogeology, Wiley Eastern Ltd, India.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓		✓	✓	
CO2	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓

SEMESTER - V				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5055	**Natural Hazards**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand major natural hazards—their nature, causes, impacts, and associated concepts such as risk, vulnerability, and disaster management.	Understand
CO2	analyze processes, triggers, and impacts of natural hazards to interpret patterns, assess regional vulnerability.	Analyze
CO3	apply hazard identification and assessment tools-including seismic zoning maps, flood/drought indices, coastal vulnerability indicators, and remote sensing-GIS-to evaluate hazard-prone regions.	Apply

b. Syllabus

Units	Content	Hrs.
I	Definition and significance of natural hazards; classification into atmospheric, hydrological, geological, and biological hazards. Concepts of hazard, risk, vulnerability, and disaster. Overview of India's hazard profile and major vulnerable regions.	9
II	Earthquakes: causes, seismic waves, intensity and magnitude scales, seismic zoning of India, and mitigation strategies. Volcanoes: types, distribution, volcanic materials, eruption mechanisms, and associated hazards. Landslides: causes, types, slope instability factors, early warning indicators, and landslide-prone zones of India.	9
III	Tsunamis: generation mechanisms, wave characteristics, coastal impacts, and Indian Ocean tsunami case studies. Floods: causes, hydrographs, riverine and flash floods, flood zoning, and flood control measures. Droughts: meteorological, hydrological, and agricultural droughts and drought-prone regions of India.	9
IV	Cyclones: formation, structure, cyclone tracks over the Bay of Bengal and Arabian Sea and cyclone management. Extreme weather events including heat waves, cold waves, cloudbursts, and unseasonal rainfall. Coastal hazards: coastal erosion, shoreline changes, sea-level rise, storm surge impacts, and vulnerability of Indian coastal regions. Forest fires: causes, spread mechanisms, and ecological impacts.	9

V	Anthropogenic hazards: industrial accidents, mining-related hazards, dam failures, pollution-induced hazards. Remote sensing and GIS in hazard mapping, monitoring, and risk assessment. Early warning systems for earthquakes, tsunamis, cyclones, floods, and landslides. The disaster management cycle-preparedness, mitigation, response, and recovery.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Bryant, E. Natural Hazards, 3rd Edition, 2005.
2. Smith, K. Environmental Hazards: Assessing Risk and Reducing Disaster, 6th Edition, 2013.
3. Tobin, G.A. & Montz, B.E. Natural Hazards and Disasters, 2015.
4. Keller, E.A. Introduction to Environmental Geology, 2011.
5. Hyndman, D. & Hyndman, D. Natural Hazards and Disasters, 5th Edition, 2016

Reference Books

1. Bolt, B.A. (2004). Earthquakes, 6th Edition.
2. Abbott, P.L. (2014). Natural Disasters.
3. Burton, I., Kates, R.W. & White, G.F. (1993). The Environment as Hazard, 2nd Edition.
4. Alexander, D. (2002). Principles of Emergency Planning and Management.
5. Coppola, D. (2015). Introduction to International Disaster Management, 3rd Edition.
6. Sharma, V.K. (2014). Disaster Management.
7. Pielke, R. (2019) The Future of Disaster Risk Reduction.
8. Ramana Murthy, M.V. (2015). Tsunamis: Detection, Monitoring, and Early Warning.
9. Gupta, H.K. & Kumar, S. (2012). Seismology and Seismic Hazards in India.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		✓
CO2		✓	✓			✓
CO3	✓		✓	✓	✓	✓

SEMESTER - V				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5056	**Palaeontology (Practical)**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Analyze fossil assemblages and stratigraphic data to interpret evolutionary trends, palaeoecology, palaeoenvironment, and palaeogeographic patterns.	Analyze
CO2	apply fossil identification, handling, and documentation techniques, and use morphological and taxonomic principles to describe, sketch, and classify invertebrate, vertebrate, and plant fossils.	Apply

b. Syllabus

Units	Content	Hrs.
I	Basic identification and handling of fossils, with emphasis on fossil preservation types such as molds, casts, carbonized remains, and permineralized specimens.	12
II	Study of major invertebrate fossil groups, including trilobites, brachiopods, molluscs, corals, and echinoids. Diagnostic morphological characters, preparation of systematic descriptions, and clear sketches of important structures.	12
III	Identification and interpretation of vertebrate and plant fossils. Examination of vertebrate fossil casts or images. Identification of Gondwana flora, gymnosperm leaves, pteridophyte impressions, and early land plant remains.	12
IV	Microscopic study of microfossil groups, including foraminifera, radiolaria, ostracods, spores, and pollen. Identification of basic morphological types using slides or images. Study of important fossiliferous horizons of India using charts, maps, and stratigraphic sections.	12
V	Fossil-based exercises focusing on paleoecological and palaeoenvironmental interpretation. Analysis of fossil assemblages to infer environmental conditions. Use of fossil evidence to reconstruct the paleoclimate and paleobiogeographic patterns.	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Text Books

1. Clarkson, E.N.K. Invertebrate Paleontology and Evolution, 1998.
2. Benton, M.J. & Harper, D.A.T. Fossils at a Glance, 2009.
3. Taylor, T.N., Taylor, E.L. & Krings, M. Paleobotany, 2009.
4. Armstrong, H.A. & Brasier, M.D. Microfossils, 2005

Reference Books

1. Moore, R.C., Lalicker, C.G. & Fischer, A.G. Invertebrate Fossils, 1952.
2. Benton, M.J. Vertebrate Paleontology, 2014.
3. Foote, M. & Miller, A.I. Principles of Paleontology, 2007.
4. Jansonius, J. & McGregor, D.C. Palynology: Principles and Applications, 1996.
5. Kneitel, D.V. & Stanley, J.D. Historical Geology, 2012..

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓			✓
CO2	✓			✓	✓	✓

SEMESTER - V				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5057	**Hydrogeology and Remote Sensing (Practical)**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	use the rainfall and hydrological data for analysis	Analyze
CO2	use the aerial and remote sensing data in geological studies	Apply

b. Syllabus

Units	Content	Hrs.
I	Various types of water body identification from the toposheet and other sources; river, stream, canal, reservoir, pond, tank, well extraction from Survey of India toposheet in 1:50,00 scale and 1: 250,000 scale.	12
II	Opensource data extraction for hydrological studies, water quality and quantity studies	12
III	Aerial photo scale and its types, calculations	12
IV	Spatial and spectral resolutions and uses	12
V	Drone, Aerial and remote sensing data interpretation, and features identifications	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Text Books

1. K. N., Mutreja.,(1982). Applied Hydrology. Tata McGraw-Hill Publishing Company Ltd.New Delhi.
2. Raghunath, H.M., (1983). Groundwater. Wiley Eastern, Calcutta (India)

Reference Books

1. Arul, P., (2000). A Text Book of Ground Water. Classic Printers, Chennai

2. Anbazhagan, S., Jothibasu, A. & Balamurugan, G., (2019), Climate Change in Water Resources. Allied Publishers, New Delhi, India.

3. Bouwer, H., (2014), Groundwater Hydrology, McGraw hill education private limited.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓			✓	✓	
CO2	✓	✓	✓	✓	✓	✓

SEMESTER – V				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLYEC01	**Sample Preparation Techniques in Geology-I**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	perform systematic field and laboratory sample handling procedures.	Apply
CO2	prepare geological samples for various analytical techniques	Apply

b. Syllabus

Units	Content	Hrs.
I	Importance of sample preparation in geology; Sampling strategies: representative sampling, contamination control, Sample labelling, and storage.	12
II	Types of geological samples: rocks, minerals, soils, sediments, ores, fossils, water, and core samples	12
III	Importance of grainsize in sample collection; sample collection strategies of fine, medium, coarse and very coarse grained lithologies (hard rock, sediments, soils), quantity of sample collection for various analysis.	12
IV	Field sampling methods for rocks, soils, sediments, water, and core samples; Tools and equipment used in geological sampling; Packaging, transport, and preservation techniques;	12
V	Preliminary processing in the lab: cleaning, drying, splitting, and homogenization; Avoiding contamination during field and lab handling.	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Text Books

1. Donovan, Stephen K. *A Manual of Practical Laboratory and Field Techniques in Geology*. Wiley-Blackwell, 2015.
2. Hutchison, C. S. *Laboratory Handbook of Petrographic Techniques*. Wiley, 1974.
3. Rollinson, H. R., Rollinson, H., & Pease, V. (2021). *Using geochemical data: to understand geological processes*. Cambridge University Press.
4. Gill, R. (2014). *Modern Analytical Geochemistry: an introduction to quantitative chemical analysis techniques for Earth, environmental and materials scientists*. Routledge.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓			✓
CO2	✓	✓	✓	✓	✓	✓

SEMESTER – VI				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5061	**Engineering and Mining Geology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the physical and mechanical properties or rocks and soils used in Engineering Geology	Understand
CO2	analyze the rock failure mechanism, rock mass classifications and the concept of rock slope engineering	Analyze
CO3	apply the failure criteria to determine critical stress conditions for failure and respective stabilization methods for engineering structures	Apply

b. Syllabus

Units	Content	Hrs.
I	Introduction to Engineering Geology. Engineering properties of rocks – Specific Gravity, Porosity, Permeability, Absorption. Concept of stress and strain. Strength of rocks – compressive, tensile, shear and triaxial strength, elastic modulus and Poisson's ratio of rocks and their measurement	9
II	Stress on a plane. Mohr's circle of stress and strain and theories of rock failure. Role of friction, groundwater and pore-pressure in the failure condition. Factor of Safety; Types of Failure. Discontinuities in rock masses	9
III	Weathering indices, swelling indices, durability indices. Concepts of rock mass classification – RMR and Q systems; Discontinuities. Improving slope stabilization (Anchoring; Grouting; Meshing). Geological structure consideration for evaluation of dams and reservoir sites. Landslides – concepts, classification, and analysis.	9
IV	The scope and importance of mining geology, types of mineral deposits, and their geological controls. Principles of ore formation, classification of ore bodies, and the geological characteristics influencing mining operations. Geological mapping, trenching, pitting, geophysical surveys, and geochemical techniques.	9
V	Principles of mine development and mining methods: alluvial, open-cast, and underground, mining. Mine supports, ventilation, drainage, and ore handling systems. Fundamentals of ore dressing, including crushing, grinding, screening, concentration, and beneficiation. Environmental and safety aspects of mining, including mine hazards, waste disposal, reclamation, sustainable mining practices, and the National Mineral Policy (NMP).	9

Tasks and Assignments:
Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Deb, D., & Verma, A.K., (2016), Fundamental and applications of rock mechanics. PHI Learning Private Limited.
2. Bell, F.G., (2007), Engineering geology. Taylor & Francis Group.
3. Singh, B., & Goel, R.K., (2011), Engineering rock mass classification. Elsevier Inc.

Reference Books

1. Jaeger, J.C., Cook, N.G.W., & Zimmerman, R.W., (2007), Fundamental of rock mechanics. Blackwell Publishing Ltd.
2. Mitchell, J.K., & Soga, K., (2005), Fundamental of soil behaviour. John Wiley & Sons, Inc.
3. Salgado, R., (2008), The Engineering of Foundations. McGraw Hill.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓		✓		
CO2	✓		✓		✓	✓
CO3	✓	✓		✓	✓	✓

SEMESTER - VI				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5062	**Oceanography and Climatology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the key branches of Oceanography	Understand
CO2	evaluate the importance of oceanography and climatology	Evaluate
CO3	analyze oceanographic and climatological parameters linkage	Apply

b. Syllabus

Units	Content	Hrs.
I	Physical and Biological Oceanography: T-S diagrams, mixing processes in the oceans; Wind generated waves and their characteristics; shallow and deep-water waves; Tides and tidal currents in shallow seas and estuaries; breakers and surf; Physicochemical factors affecting marine biota – light, temperature, salinity, pressure, nutrients, dissolved gases; primary and secondary production	9
II	Chemical Oceanography: Composition of seawater; classification of elements: major and minor elements, and their residence time in seawater; Chemical and biological interactions: biochemical cycling of nutrients, trace metals and organic matter	9
III	Geological Oceanography: Morphological and tectonic domains of the ocean floor; Ocean margins and their significance; Ocean sediments: factors controlling the formation and distribution of marine sediments; Mineral resources	9
IV	Climatology: Basic principles of climatology; Earth's radiation balance; latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity, cloud formation and precipitation, water balance	9
V	Air masses, monsoon, jet streams, tropical cyclones and El Nino Southern Oscillation-ENSO; Classification of climate – Koppen's scheme of classification, climate change	9
Tasks and Assignments: Each student is required to undergo the following: • Assignments		

- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Trujillo, A.P. & Thurman, H.V., (2013), Essentials of Oceanography, Pearson, Boulevard.
2. Pinet, P.R. (2000), Invitation of Oceanography, 2nd Edition, Jones and Barlett.
3. Simpson, J.H. & Sharples, J. (2012), Introduction to the Physical and Biological Oceanography of the Shelf Seas, Cambridge Uni. Press, UK.
4. Talley, L.D., Pickard, G.L., Emery, W.J. & Swift, J.H. (2011), Descriptive Physical Oceanography: An Introduction, 6th Edition, Academic Press.

Reference Books

1. Beer, T. (1997) Environmental Oceanography, CRC Press, New York.
2. King, C. (1966) An Introduction to Oceanography, McGraw Hill Book Co., New York.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	
CO2		✓	✓	✓	✓	
CO3	✓	✓		✓	✓	✓

SEMESTER - VI				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5063	**Coal and Petroleum Geology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the formation, properties, migration and accumulation of petroleum	Understand
CO2	understand the origin, occurrence and classification of coal	Analyze
CO3	explain various types of natural resources, their exploration and distribution of coal	Apply

b. Syllabus

Units	Content	Hrs.
I	Origin of coal, classification of coal, morphology, composition of peat, lignite, bituminous, anthracite. Coal series, terminology, structure and petrography of coals; physical and chemical properties of coal	9
II	Coal reserve in India; brief idea about the world coal resources; exploration of coal; utilization of coal-combustion and gasification of coal; coal and environment.	9
III	Origin of petroleum, source rock and maturation of kerogen, paleothermometers; primary and secondary migration	9
IV	Reservoirs – porosity, permeability and capillary pressure, porosity types in clastic and carbonate reservoirs, reservoir heterogeneity, drive mechanisms; traps and seals – classification of traps	9
V	Composition of petroleum, physical and chemical properties of oil; brief idea about the hydrocarbon resources of India, the classification and stratigraphy of petroliferous basins of India.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Leverson, A.L. Geology of Petroleum. Freeman and co., 1970

2. Selley, R. C. Elements of Petroleum Geology, II Edition. Academic Press, 1998

3. Petroleum Formation and Occurrence by B.P. Tissot and D.H. Welte

4. Stach, E. et al. Stach's textbook of coal petrology. Berlin: Gebruder Borntraeger, 1975

5. Taylor, G.H., Teichmüller, M.., Davis, C. Organic Petrology: A new handbook incorporating some revised parts of Stach's Textbook of Coal Petrology, 1998

6. Chandra, D., Singh, R.M., Singh, M.P. Text Book of Coal (Indian Context). Tara Printing Works, Varanasi, 2000

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓			
CO2		✓	✓	✓		
CO3		✓	✓	✓	✓	✓

SEMESTER - VI				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5064	**Indian Stratigraphy**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the principles of stratigraphy, stratigraphic classification systems, and the geological evolution of major Indian sedimentary basins.	Understand
CO2	analyze stratigraphic successions from Precambrian to Cenozoic India to evaluate basin development, tectonic influences, and major geological events.	Analyze
CO3	evaluate the principals of advanced stratigraphy and details of geological time scale	Apply

b. Syllabus

Units	Content	Hrs.
I	Basic principles of stratigraphy; lithostratigraphy, biostratigraphy, chronostratigraphy, magnetostratigraphy, and sequence stratigraphy. Walther's Law of Facies. International Stratigraphic Code and the development of standardized stratigraphic nomenclature. Geological Time Scale. Stratigraphic contacts, facies concepts, correlation methods.	9
II	Physical and structural subdivisions of the Indian subcontinent. Archaean cratons of India. Early to Late Proterozoic basins of India (Vindhyan, Cuddapah, Marwar, Chhattisgarh, Krol–Tal). Major lithounits, depositional environments, and economic significance. Marine transgressions and biostratigraphic markers.	9
III	Palaeozoic succession of the Himalaya and peninsular India. Marine Triassic and Jurassic successions of India. Marine and non-marine Cretaceous successions of Trichinopoly. Gondwana Supergroup-lithology, flora, climate, and basin development. Mesozoic sequences of Kutch, Rajasthan, and the Indian Peninsula. Stratigraphy of the Lesser Himalayan sedimentary belts.	9
IV	Cenozoic stratigraphy of the Himalaya. Deccan Volcanic Province-stratigraphy, eruption phases, and inter-trappean beds. Palaeogene and Neogene global events. Tertiary basins-Kutch, Cauvery, Krishna-Godavari, Bengal, and Andaman–Nicobar. Siwalik successions.	9
V	Important stratigraphic boundaries in India. Concept of paleogeographic reconstruction. Stratigraphy in resource exploration-coal-bearing Gondwana and petroleum-bearing Tertiary basins. Paleogeographic evolution of the Indian subcontinent.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Dunbar, C.O. & Rodgers, J., (1957), Principles of Stratigraphy. JohnWiley & Sons.
2. Krishnan, M.S., (1982), Geology of India and Burma. C.B.S. Publishers, Delhi
3. Kumar, R., (2018), Fundamentals of Historical Geology and Stratigraphy of India. New Age International Publisher.
4. Naqvi, S.M. & Rogers, J.J.W., (1987), Precambrian Geology of India. Oxford University Press.
5. Vaidyanathan R. & Ramakrishnan M., (2008), Geology of India. Geological Society of India.

Reference Books

1. Krishnan, M.S. (2006). Geology of India and Burma. CBS Publishers & Distributors, New Delhi.
2. Kumar, Ravindra (1995). Fundamentals of Historical Geology and Stratigraphy of India. New Age International Publishers, New Delhi.
3. Valdiya, K.S. (2015). The Making of India: Geodynamic Evolution. Springer, New Delhi.
4. Wadia, D.N. (1999). Geology of India. CBS Publishers & Distributors, New Delhi.
5. Banghar, K.C. & Valdiya, K.S. (1998). Indian Geology. Tata McGraw-Hill, New Delhi.
6. Bose, P.K., Chakraborty, C., Sarkar, S., et al. (2016). Indian Sedimentary Basins: Stratigraphy, Tectonics and Hydrocarbon Prospects. Springer, Cham.
7. Nair, K.M. (2011). Geology of Kerala and South India. Geological Society of India, Bengaluru.
8. Ray, J.S. & Pandey, D.K. (2020). The Indian Subcontinent and the Gondwana: Geology and Resources. Springer, Singapore.
9. Catuneanu, O. (2006). Principles of Sequence Stratigraphy. Elsevier, Amsterdam.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓			✓
CO2	✓	✓		✓		✓
CO3		✓	✓		✓	✓

SEMESTER - VI				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5065	**Geological Field Visit**	**-**	**4**	**4**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the geological geomorphological features from toposheets and images/photographs	Understand
CO2	get an exposure to geological and structural mapping	Apply
CO3	gain essential skills for mapping, interpretation and geological resource mapping	Skill
CO4	create geological field reports	Create

b. Syllabus

Units	Content	Hrs.
I	Rock and Fossil identification and characterization, including strike and dip measurements, collection of samples, and its analysis	**32**
II	Structural mapping: Faults, folds, joints, and unconformities and their relationships	**32**
III	Geomorphological mapping: studying the various landforms; mountains, hills, valleys, pediments, flood plains, coastal and different drainage patterns	**32**
IV	Geological mapping: creating the geological map and cross section from existing map (toposheet, geological map and other published maps)	**32**
V	Reports and presentation – Report consist of the Unit-I to Unit-IV and they must prepare and present it neatly; should contain the information like geology, stratigraphy, toposheet number, field photograph and samples.	**32**

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Field reports
- Seminars
- Viva-voce

Text Books

1. Bloom, A., (2005), Geomorphology. Pearson. New Delhi
2. Burbank, D. W. & Anderson, R.S., (2016), Tectonic Geomorphology. Wiley India
3. Keller, E.A & Pinter, N., (2001), Active Tectonics. 2nd Edition. Pearson Publications
4. Mathur, S. M., (2001), Guide to Field Geology. Prentice Hall India. New Delhi.

Reference Books

1. Small, R.J., (1978), Study of Landforms: A Textbook of Geomorphology (2nd Edition), Cambridge University Press.
2. Thornbury, W.D., (2002), Principles of Geomorphology, John Wiley and Sons, 2nd Edition, New York.
3. Leopold, L., Wolman, C. And Miller, J. P., (1963), Fluvial Processes in Geomorphology. Freeman.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓		✓	✓	✓	
CO3		✓	✓		✓	
CO4	✓	✓	✓		✓	✓

SEMESTER - VI				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLYEC02	**Fundamentals of Geophysics**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the fundamental Geophysical Concepts	Understand
CO2	analyze the physical properties of Earth materials and their controlling factors	Analyze
CO3	apply various geophysical methods in mineral exploration	Apply

b. Syllabus

Units	Content	Hrs.
I	Basic concepts of Geophysics - Fundamental concepts of Physics; Introduction to Principles; Introduction of various geophysical methods and the controlling physical property; Active and Passive exploration	9
II	Electrical Methods – Telluric current, Resistivity, Induced Polarization, Self-Potential method. Various electrode configurations for resistivity sounding and profiling methods, interpretation and applications of resistivity data	9
III	Earth's Gravitation, anomalies and Interpretation Laws, Instruments and Gravity Methods, Gravity corrections and anomalies; Magnetic survey: land, airborne and marine magnetic survey and corresponding application	9
IV	Seismology and Internal Structure of the Earth; Seismic Method – Seismic Reflection, Refraction, Acoustic Impedance, Critical Depth, Cross-Over Distance. Induced Polarization Method, Self-Potential Method	9
V	Geophysical well-logging, and their application of logging tools including spontaneous polarization, resistivity, litho-density, neutron, natural gamma ray. Application of Geophysics in exploration	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. W.M. Telford, L.P. Geldart, R.E. Sheriff, Applied Geophysics, Cambridge University press, Second Edition
2. William Lowrie, Fundamental of Geophysics, Cambridge University Press , 2nd edition, 2007
3. Schlumberger Manual Log Interpretation Principles/Applications, Vol. 1 & 2, Schlumberger Education Services, New York, 1989

Reference Books

1. Milton B. Dobrin and Carl H. Savit, Introduction to Geophysical Prospecting, Mcgraw-Hill College , 4th sub-edition, 1998
2. Kearey, P., Brooks, M., & Hill, I. (2002). An introduction to geophysical exploration. John Wiley & Sons.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓				✓
CO2	✓	✓		✓	✓	
CO3		✓	✓	✓	✓	✓

SEMESTER – VI				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLYEC03	**Sample Preparation Techniques in Geology-II**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	prepare the samples for analysis	Apply
CO2	collection, diagnosis and analysis	Skill

b. Syllabus

Units	Content	Hrs.
I	Cutting, crushing and pulverizing of samples of igneous sedimentary and metamorphic rocks; sieving methods: dry and wet sieving, sieve analysis- Safety protocols for mechanical preparation.	12
II	Sub-sampling techniques: sample homogenization, quantification of samples; sample reduction by cone-and-quarter method; Safety protocols for mechanical preparation.	12
III	Preparation of unconsolidated sediments for granulometry; Ore and mineral samples, Microfossil extraction techniques.	12
IV	Rock samples cutting, grinding and polishing for thin section preparation overview; Sample preparation for various geophysical and geochemical analyzes.	12
V	Sample preparation for major oxides, minor elements, trace elements analysis by X-Ray Diffractometer (XRD), X-Ray Fluorescence Spectroscopy (XRF) and Inductively Coupled Plasma Mass Spectrometer (ICP-MS) and other instruments.	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Text Books

5. Donovan, Stephen K. *A Manual of Practical Laboratory and Field Techniques in Geology*. Wiley-Blackwell, 2015.
6. Hutchison, C. S. *Laboratory Handbook of Petrographic Techniques*. Wiley, 1974.
7. Rollinson, H. R., Rollinson, H., & Pease, V. (2021). *Using geochemical data: to understand geological processes*. Cambridge University Press.
8. Gill, R. (2014). *Modern Analytical Geochemistry: an introduction to quantitative chemical analysis techniques for Earth, environmental and materials scientists*. Routledge.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓			✓
CO2	✓	✓	✓	✓	✓	✓

SEMESTER – VI				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLYIN01	**Internship**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	gain in-depth learning during industrial attachment	Analyze
CO2	get Industrial exposure which helps in their growth and development preparation for professional work	Skill

b. Syllabus

	Content	Weeks.
	Students are required to undergo an industrial training/ Internship in the given time. The industrial training/ Internship involving the application of the principles and methods of geological/ machineries/ explorations with respect to the concern organisation. They should get the information regarding the working principles of the industry. This experience will prepare the students to the real working environment and enhance the students' ability to meet the needs of the industry. Students are required to submit a written report on their industrial training/ Internship and they must prepare to present it neatly.	2

Tasks and Assignments:

Each student is required to undergo the following:

- Industrial training/ Internship reports
- Presentation
- Viva-voce

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓

SEMESTER – VII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5071	**Structural Geology and Tectonics**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	predict the concept of stress forces acting in the earths and its resultant structural changes, explain concept of strain and its significance.	Understand
CO2	explain the relation between deformation and crystallization and Geometrical analysis of petrofabric elements.	Analyze
CO3	assess the theory of plate tectonics	Apply

b. Syllabus

Units	Content	Hrs.
I	Mechanical properties of rocks; concept of stress, stress in two and three dimensions; Mohr diagrams. concept of strain; types of strain ellipses and ellipsoids – their properties and geological significance; strain markers and methods of strain measurements in naturally deformed rocks. mechanisms of rock deformation; mechanics of folding and buckling; distribution of strain in folds; superposed folding patterns.	9
II	Causes and dynamics of faulting; types and mechanism of faulting: normal faults, reverse faults, and strike-slip faults; thin-skinned deformation; thrust geometry and fault-related folds. geometry and types of shear zones: brittle and ductile shear zones; products of shear zone: breccia, cataclastic and mylonites series.	9
III	Time relation between deformation and crystallization. concept of petrofabric; planar and linear fabrics in deformed rocks: their origin and significance; stereographic and equal-area projections for presenting fabrics elements, and π and β diagrams; geometrical analysis of structures on macroscopic scale: use of universal stage.	9
IV	Introduction to geotectonics; continental drift, seafloor spreading, paleomagnetism, polar wandering, and reversal of earth's magnetic field; convection current hypotheses. principal geotectonic features: features of the ocean, continent and continental margins.	9

V	Plates and plate boundaries; principles of plate tectonics; force balance and mantle plume models of plate movements; orogeny and epeirogeny; anatomy of orogenic belts; geodynamic evolution of Himalaya.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Billings, M. P., (1987), Structural Geology, 4th edition, Prentice-Hall.
2. Fossen, H., (2010), Structural Geology. Cambridge University Press.
3. Ghosh, S.K., (1993), Structural Geology: Fundamentals and Modern Developments. Pergamon Press.
4. Gokhale, N. W. : Theory of Structural Geology. CBS Publishers.
5. Ragan, D.M., (2009), Structural Geology: An Introduction to Geometrical Techniques, 4th Edition. Cambridge University Press.
6. Twiss, R.J. & Moores, E.M., (2006), Structural Geology, 2nd Edition. W. H. Freeman.

Reference Books

1. Hobbs, B.E., Means, W.D. & Williams, P.F., (1976), An outline of Structural Geology. John Wiley and Sons. New York.
2. Jayangondperumal, R. Thakur, V.C., Vivek, J., Priyanka, R.S. & Gupta, A.K., (2018), Active Tectonics of Kumaun and Garhwal Himalaya, 151 pp. Springer Natural Hazard Series.
3. Lisle, R.J., (2004), Geological Structures and Maps: A Practical Guide, 3rd Edition. Elsevier.
4. Marshak, S. & Mitra, G., (1988), Basic Methods of Structural Geology. Printice Hall.
5. Novin, C. M. Principles of structural Geology John Willey, New York.
6. Pollard, D.D. & Fletcher, R.C., (2005), Fundamentals of Structural Geology Cambridge University Press
7. Ramsay, J.G. & Huber, M.I., (1983), Techniques of Modern Structural Geology, Vol. I, Strain Analysis. Academic Press.
8. Ramsay, J.G. & Huber, M.I., (1987), Techniques of Modern Structural Geology, Vol. II, Folds and Fractures. Academic Press.
9. Ramsay, J.G., (1967), Folding and fracturing of rocks. McGraw Hill.
10. Rowland, S.M. Duebendorfer, E.M. & Schiefelbein, I.M., (2007), Structural Analysis and Synthesis: A Laboratory Course in Structural Geology, 3rd edition. Wiley-Blackwell.

11. Turner, F.J. & Weiss, L.E., (1963), Structural analysis of Metamorphic Tectonites. McGraw Hill.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓	✓		✓	✓	✓
CO3	✓	✓	✓	✓		

SEMESTER - VII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5072	**Geochemistry and Isotope Geology**	**4**	**-**	**4**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the fundamentals of geochemistry and various geological processes associated with lithosphere and hydrosphere	Understand
CO2	apply the basics of radiogenic isotope geochemistry in the field of geochronology and petrogenesis	Apply
CO3	apply the principles of stable isotope geochemistry in the field of paleoclimatic studies	Analyze
CO4	explain various chemical weathering processes and its effect in the chemical composition of different types of sediments and water	Skill

b. Syllabus

Units	Content	Hrs.
I	Earth System Science and various reservoirs. Formation of Universe and Origin of elements. Introduction to the chemical composition and properties of atmosphere, lithosphere, hydrosphere and biosphere. Meteorites, their classification, mineralogy and origin.	12
II	Geochemical cycles. Concept of biogeochemical cycle. Concept of equilibrium. Entropy, enthalpy, Gibbs free energy and laws of thermodynamics. Chemical kinetics in geoscience and its applications: disequilibrium textures and diffusion.	12
III	Geochemical classification of elements. Element partitioning in mineral/rocks formation and concept of distribution coefficient and bulk distribution coefficient. Trace element Geochemistry, Interpretation of REE and PGE patterns, The utility of trace elements in the petrogenesis of rocks.	12
IV	Stable isotope geochemistry of carbon and oxygen and its applications to Geology. Radiogenic isotopes, mass fractionation. Decay scheme of K-Ar, U-Th-Pb, Rb-Sr and Sm-Nd. Radiometric dating of single minerals and whole rocks. Petrogenetic implications of Sm-Nd, Rb-Sr systems. Isotopes as petrogenetic indicators, model ages, interpretation of chronological data, isotope reservoirs.	12

V	Acids and bases. Ionisation constants of acids, bases and hydroxides. Estimation of ionic concentration. Introduction to sedimentary geochemistry. Geochemical processes involved in rock weathering and soil formation. Fugacity and activity. Oxidation-Reduction reactions. Redox potential – limits of p^H and E^h in nature. Eh-pH diagrams. A brief introduction to the hydro-geochemistry, various graphical representation methods for water analysis data.	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Albarede, F., (2009), Geochemistry an Introduction, Cambridge Univ. Press, (2nd) 330p
2. Gill, R. (2014). Chemical fundamentals of geology and environmental geoscience. John Wiley & Sons.
3. Mason, B. & Moore, C. B., (1982), Principles of Geochemistry, Wiley Eastern Ltd., 344p.
4. Misra, K. C., (2012), Introduction to geochemistry: principles and applications. John Wiley & Sons.
5. White, W. M., (2020), Geochemistry. John Wiley & Sons.

Reference Books

1. Beus, A. A. & Grigorian, S. V., (1977), Geochemical Exploration Methods for Mineral Deposits, Applied Publication, University of California, 287p.
2. Dickin, A. P., (2005), Radiogenic Isotope Geology, Cambridge University Press, 492p (II Ed)
3. Faure, G., & Mensing, T. M., (2005), Principles and applications (p. 897). John Wiley & Sons, Inc.
4. Hawkes, H. E. & Webb, J. S., (1962), Geochemistry in Mineral Exploration, Harper & Row.
5. Krauskopf, K. B. & Bird, D. K., (1995), Geochemistry, McGraw Hill, New York,640p Suggested Reading:
6. Levinson, A.A., (1980), Introduction to Exploration Geochemistry, (2nd Ed) App. Pub., 924p.
7. McSween, H. Y., Richardson, S. M., & Uhle, M. E., (2003), Geochemistry: pathways and processes. Columbia University Press.

8. Rollinson, H. R., (2014), Using geochemical data: evaluation, presentation, interpretation. Routledge.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓		✓	✓
CO2	✓	✓	✓	✓		✓
CO3	✓		✓			
CO4	✓		✓	✓		✓

SEMESTER - VII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5073	**Ore Geology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the genetic controls exerted by physical and chemical processes on ore formation in various geologic settings	Understand
CO2	recognize common ore and economic minerals and awareness about distribution of mineral deposits in India.	Analyze
CO3	explain ores genesis of magmatic, sedimentary and metamorphic affiliations and correlate with world-class ore mineral deposits.	Apply

b. Syllabus

Units	Content	Hrs.
I	Nature and morphology of ore deposits; Ore textures and its application; Ore-Bearing Fluids; Paragenesis, application of geothermobarometry and Fluid inclusion study: Principles, assumptions, limitations and applications of fluid inclusions in ores;	9
II	Wall rock alteration; Process of formation and transformation of ores; Controls of ore localization; Classification of ore deposits (based on origin, ore forming processes, tectonics, etc.); Physical and optical properties of ore minerals.	9
III	General characteristics and genesis of magmatic ore deposits – Light rare earth elements ores, chromite deposits, base-metal Ni-Cu sulfide deposits, PGE sulfide deposits, rare-metal pegmatites and diamond deposits associated with kimberlites and lamproite.	9
IV	General characteristics and genesis of hydrothermal, stratiform and strata-bound deposits; skarn and carbonate-replacement deposits; epithermal deposits; volcanic-hosted massive sulfide deposits; orogenic gold deposits; iron oxide-copper-gold (IOCG) deposits; MVT and SEDEX deposits; other deposits of hydrothermal affiliation.	9
V	Ores of sedimentary affiliation: Hydrogene and clastic sedimentation deposits - Iron ores in ironstones; sedimentary-rock-hosted Mn and P deposits; heavy mineral sand deposits; and placer deposits; Residual deposits and supergene enrichment. Ores of metamorphic affiliations. Significance of crustal evolution in the metallogenesis. Occurrence, origin and distribution of the important metallic and nonmetallic mineral deposits of India; Strategic, Critical and Essential minerals; National Mineral Policy of India.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Barnes, H.L., (1979), Geochemistry of Hydrothermal Ore Deposits. John Wiley.
2. Bateman, A.M., & Jensen, M. L., (1950), Economic mineral deposits. (Vol. 259) John Wiley & sons.
3. Evans, A.M., (1993), Ore Geology and Industrial Minerals. Blackwell.
4. Park, C.G., (1972), Ore Deposits. McDiarmid.
5. Robb, L. (2005). Introduction to ore-forming processes. Blackwell.

Reference Books

1. Golbert, J.M. & Park, C., (1986), The Geology of Ore Deposits. W.H. Freeman & Co New York.
2. Klemm, D.D. & Schneider, H.J., (1977), Time and Strata Bound Ore Deposits. Springer Verlag.
3. Mookherjee, A., (2000), Ore Genesis - A Holistic Approach. Allied Publisher
4. Pracejus, B., (2015), The ore minerals under the microscope: an optical guide. (Vol. 3, 2nd Ed.) Elsevier.
5. Ramdohr, P., (1969), The Ore Minerals and their Intergrowths. Pergamon Press.
6. Ridley, J., (2013), Ore deposit geology. Cambridge University Press.
7. Stanton, R.L., (1972), Ore Petrology. McGraw Hill.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓		✓	✓
CO2	✓		✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓

SEMESTER - VII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5074	**Mining Geology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand fundamentals of mining geology, ore formation, exploration, mining methods, ore dressing, and environmental and safety practices.	Understand
CO2	analyze geological and exploration data, evaluate ore bodies, mining methods, and post-mining impacts.	Analyze
CO3	apply mining, ore dressing, beneficiation, and safety techniques for resource evaluation and sustainable mining operations.	Apply

b. Syllabus

Units	Content	Hrs.
I	Fundamentals of mining geology and the role of geology in mineral resource exploration. Classification of mineral deposits, and basic concepts of ore formation and genesis. Geological controls on mineralization-deposit types, host rock, structure, and tectonic settings. Life-cycle of mineral exploration: prospecting, reconnaissance, sampling, and resource estimation.	9
II	Methods employed in mineral exploration: geological mapping, trenching, pitting, drilling and core logging, geophysical and geochemical prospecting techniques, and remote-sensing/ GIS methods. Sampling strategies (surface, subsurface) and basic methods for reserve and resource estimation.	9
III	Mining methods appropriate for different deposit types: surface mining including open-cast, alluvial, placer, quarrying; and underground mining. Shafts, adits, drift, winze, raise, stoping methods, pillar-supported stopes. Factors influencing the choice of mining method. Mine layout design, mine supports, ventilation, drainage, haulage, and basic mine planning practices.	9
IV	Post-mining processes: ore dressing and beneficiation. Crushing, grinding, screening, size segregation, concentration methods (gravity separation, magnetic, flotation), beneficiation of ores, recovery of metals and industrial minerals, treatment of gangue, and management of tailings.	9
V	Environmental, safety, and regulatory aspects of mining. Mine hazards, occupational safety, waste management, mine-waste disposal, tailings management, land reclamation, mine closure. National/international	9

	mining laws and policies, sustainable mining practices, and conservation of mineral resources.	

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Davis, G.H. & Reynolds, S.J. (1996). Structural Geology of Rocks and Regions, 2nd Edition.
2. Park, C.F. & MacDiarmid, R. (2013). Introduction to Mineral Exploration, 3rd Edition.
3. Gupta, R.P. (2014). Mining Geology, 2nd Edition.
4. Kuhn, S. & Keller, A. (2012). Mineral Exploration and Mining Methods, 1st Edition.
5. Hustrulid, W.A. & Bullock, R.L. (2001). Underground Mining Methods: Engineering Fundamentals and International Case Studies, 2nd Edition

Reference Books

1. Crundwell, F.K., et al. (2011). Introduction to Mineral Processing, 2nd Edition.
2. Hartman, H.L. (1992). SME Mining Engineering Handbook, Volumes 1–2.
3. Evans, A.M. (2014). Ore Geology and Industrial Minerals, 4th Edition.
4. Brown, K.M. & Marsden, J.O. (2007). Surface Mining Methods and Applications, 2nd Edition.
5. Gupta, R.P. (2010). Elements of Mining Engineering.
6. Vaughan, D.J. & Craig, J.R. (2013). Mineral Chemistry of Ore Deposits, 2nd Edition.
7. Miller, J.M. (2009). Mining Geostatistics, 1st Edition.
8. Marsden, J.O. & House, G. (2006). The Chemistry of Gold Extraction, 2nd Edition.
9. Wills, B.A. (2015). Mineral Processing Technology, 8th Edition.
10. Sahoo, B.K. & Singh, A.K. (2012). Environmental Management in Mining, 1st Edition.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		✓
CO2	✓		✓			✓
CO3	✓		✓		✓	✓

SEMESTER - VII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5075	**Engineering Geology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	explain various physical and mechanical properties or rocks and soils used in engineering geology	Understand
CO2	study the soil classification and importance of soil behavior for foundation engineering	Analyze
CO3	study rock failure mechanism, rock mass classifications and the concept of rock slope engineering	Apply

b. Syllabus

Units	Content	Hrs.
I	Introduction to Engineering Geology. Engineering properties of rocks – Physical and mechanical properties of rocks; Specific Gravity, Porosity, permeability, Absorption, Strength of rocks, compressive, tensile, shear and triaxial strength, elastic modulus and Poisson's ratio of rocks and their measurement.	9
II	Concepts of stress, strain. Mohr's circle of stress and strain and theories of rock failure. Determination of in-situ stresses. Discontinuities in rock masses. Concepts of rock mass classification – RMR and Q systems. Engineering Geological investigations related to highways, buildings, bridges. Geological consideration for evaluation of dams and reservoir sites.	9
III	Methods of tunneling; Classification of ground for tunneling purposes; various types of support. Rock slope engineering - factors influencing slope stability, analysis of slope failure, monitoring of slope stability, improving slope stability. Landslides – concepts, classification, and analysis.	9
IV	Soil classification, unified soil classification system, clay minerals and their structure. Weight – volume relationship of soil, Index properties of soil. Consolidation of soil. Strength properties of soils and their determination in laboratory. Atterberg limits.	9
V	Weathering indices, swelling indices, durability indices. Bearing capacity and California bearing ratio (CBR) of soils and foundations of Engineering Structures. Shoreline engineering geology. Rock as construction materials and aggregate properties.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Bell, F.G., (2007), Engineering geology. Taylor & Francis Group.
2. Singh, B. & Goel, R.K., (2011), Engineering rock mass classification. Elsevier Inc.
3. Waltham, T., (2002), Foundations of Engineering Geology. Elsevier Ltd.
4. Wood, D.M., (1990), Soil behaviour and critical state soil mechanics. Cambridge University Press.

Reference Books

1. Deb, D. & Verma, A.K., (2016), Fundamental and applications of rock mechanics. PHI Learning Private Limited.
2. Jaeger, J.C., Cook, N.G.W. & Zimmerman, R.W., (2007), Fundamental of rock mechanics. Blackwell Publishing Ltd.
3. Mitchell, J.K. & Soga, K., (2005), Fundamental of soil behaviour. John Wiley & Sons, Inc.
4. Salgado, R., (2008), The Engineering of Foundations. McGraw Hill.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓		✓	✓
CO2	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓		✓	✓

SEMESTER - VII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5076	**Geochemistry and Ore Geology (Practical)**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	familiarize with various modern analytical instruments, geochemical calculations, and interpretation of geochemical results	Analyze
CO2	identify the important ore and economic minerals.	Apply

b. Syllabus

Units	Content	Hrs.
I	Chemical elements in the earth's crust; pathfinders and common geochemical associations of elements. Methods of geochemical sampling. Sampling procedures and introduction to important analytical techniques used in geochemistry, Hands on training of solution preparation for analysis,	12
II	Analytical principles and procedures: XRF, ICP-MS, EPMA and SEM-EDS, sample preparation, presentation of analytical data, geochemical reference materials, accuracy and precision, basic statistics used in geochemistry, oxidation states and volatile, FeO, Fe_2O_3 and Total Fe, Mg#, mole conversions and mineral formulae calculations.	12
III	Identification and description of the common economic minerals including asbestos, carbonate, sulphate, phosphate, fluoride, oxide and sulphide minerals using the Megascopic study.	12
IV	Demonstration and study of ore microscope and identification of their properties under reflected light of sulfides and sulphate minerals such as pyrite, chalcopyrite, sphalerite, galena, Bornite, Pyrrhotite, Chalcocite, Covellite, Marcasite, Arsenopyrite etc	12
V	Microscopic observation and description and their genesis of the common ore minerals oxide minerals and their paragenesis. – Magnetite, Hematite, goethite, asbestos, carbonate, phosphate, fluoride, etc.	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Reference Books

1. Potts, P.J., (2003), Handbook of Rock Analysis. Viridian Publishing, UK.
2. Rollinson, H. R., (2014), Using geochemical data: evaluation, presentation, interpretation. Routledge.
3. Craig J. R. & Vaughan, D. J., (1994), Ore Microscopy and Petrography.
4. Cuilbert, J.M. & Park,Jr. C.F., (1986), The Geology of Ore Deposits, Freidman.
5. Ramdhor, P., (1969), The Ore Minerals and their Intergowths, Pergamon Press.
6. Stanton, R.L., (1972), Ore Petrology, McGraw Hill.
7. Wolf, K.H., (1976-1981), Handbook of Stratabound and Stratiform Ore Deposits, Elsevier Publication

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓		✓	✓	✓
CO2	✓		✓	✓	✓	✓

SEMESTER - VII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5077	**Structural Geology and Tectonics (Practical)**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	solve the problems based on orthographic and stereographic projections, study of geological maps and sections	Analyze
CO2	quantify the geological strains and study of dip-isogons.	Apply

b. Syllabus

Units	Content	Hrs.
I	Preparation and interpretation of geological maps and sections: nature of structural geology, detailed structural analysis: base maps and mapping procedures, primary contact relationships, and secondary structures.	12
II	Faults: classification (slip sense, shape, basement-involvement), experimental modeling of normal-fault development, thickness, outcrop width, depth, cross sections, vertical exaggeration, faults: slip vs. separation, block diagrams, maps and cross sections, joints and veins	12
III	Folds: block diagrams, folding processes and mechanisms, folds: maps and cross sections, fault, fold, foliation, strike, dip, order of super position structural problems based on orthographic and stereographic projections concerning economic deposit. geometry and nomenclature	12
IV	Force & stress; Mohr circles, brittle deformation joints & veins, faults, stereographic projections. Recording and plotting of the field data. study of the hand specimen of deformed structures.	12
V	Strength and tectonics; structures associated with plate boundaries; contour maps: rule of V's, structure-contour and isopach maps, contour, lithological - simple and complex problem	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce

- Class Tests

Text Books

1. Lisle R.J. &Leyshon, P.R., (2004), Stereographic Projection Techniques for Geologists and Civil Engineers, 2 edition, Cambridge University Press
2. Lisle, R.J., (2004), Geological Structures and Maps: A Practical Guide, Third Edition. Elsevier
3. Turner, F.J. & Weiss, L.E., (1963), Structural Analysis of Metamorphic Tectonites McGraw Hill Book Co.

Reference Books

1. Ramsay, J.G. & Huber, M.I., (1983), Techniques of Modern Structural Geology. Vol. I. Strain Analysis. Academic Press.
2. Ramsay, J.G. & Huber, M.I., (1987), Techniques of Modern Structural Geology. Vol. II. Folds and Fractures. Academic Press

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓

SEMESTER - VII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5078	**Mining and Engineering Geology (Practical)**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	distinguish between open-cast and underground mining methods using charts and models. To study and interpret mine sections and layouts.	Analyze
CO2	understand the concept of measurement of various mechanical and physical properties of rocks and soils and have important information about the instrumentation used in engineering geology	Apply

b. Syllabus

Units	Content	Hrs.
I	Identification of mining methods: open-cast and underground (using charts/models), Study and interpretation of mine sections and layouts, Identification and labeling of mine components.	12
II	Megascopic identification of common ore minerals (hand specimens), Study and classification of ore deposit types: magmatic, hydrothermal, sedimentary, placer (using samples/figures), Recognition of ore textures and structures from specimens and images.	12
III	Demonstrative study of drilling and blasting methods (charts/videos), Identification and use of common mining tools and equipment, Study of shaft sinking, tunneling, and stoping methods through diagrams/models.	12
IV	Measurement of various engineering properties of rocks and soils. Instrumentation in engineering geology. Study of properties of common rocks with reference to their utility in engineering projects.	12
V	Direct and indirect methods of determination compressive, tensile, shear and triaxial strength of rock; modulus of elasticity and Poisson's ratio; dynamic modulus of elasticity; porosity of rock.	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce

- Class Tests

Text Books

1. Hartman, H. L. (Ed.). (2011). *SME mining engineering handbook* (3rd ed.). Society for Mining, Metallurgy & Exploration.

2. Society for Mining, Metallurgy & Exploration. (2011). Underground mining methods: Engineering fundamentals and international case studies.

3. Singh, B., Goel, R.K. (2011). Engineering rock mass classification. Elsevier Inc.

Reference Books

1. Parbin Singh, Engineering and General Geology, Eight Revised Edition, Published by S.K. Kataria & Sons.
2. Deb, D., Verma, A.K. (2016). Fundamental and applications of rock mechanics. PHI Learning Private Limited.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓

B.Sc. Hons - Degree

SEMESTER - VIII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5081	**Research Project**			**6**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	gain a deeper level of understanding in the chosen area of research, together with the knowledge of past work in that area and learning to carry out a research project, is a significant objective.	Analyze
CO2	develop and evaluate the theoretical and empirical positioning of the selected topic.	Apply
CO3	conduct research on the selected topic in a methodologically sound way and write up the results and analysis in a dissertation with a logical structure that considers the evidence in systematic and even creative way.	Create

Content	Weeks
Research is a quest for knowledge, or a systematic investigation, with an openness, and the aim may be to establish novel facts, solve new or existing problems, prove new relationships or develop new theories or explore and establish inter-relationships. The research dissertation offers Masters' students the opportunity to produce work of originality and to contribute to knowledge in the field of Geology. Students will gain hands-on experience in conceptualising and conducting a formal research project including collecting, analysing and interpreting data and writing a publishable quality dissertation. Thus, this component will provide students an opportunity to engage with research methodology through direct and active involvement in conducting a research study. The dissertation will also enable students to utilise and integrate knowledge gained from course work in the B.Sc. (Hon) programme and either extend this knowledge or apply it in a relevant manner further explore an issue, a problem or an area of inquiry. The research is expected to contribute to influencing policies, building theory for improving practice, and possible applications of the knowledge gained. The outcome of research may be new knowledge leading to improved understanding of the world around us and the development of new and improved procedures or establishing sharper relationship between factor or issues. To ensure that research results are shared, it must be disseminated in an appropriate manner. In many ways, the dissemination of the research results is just as important as the	10

research activity itself. There are many ways to disseminate research results, and the production of a research dissertation is one of them. A research dissertation contains elements which distinguish it from other types of reports and documentation. Because it is the culmination of several months of work, the written document can be quite voluminous. Writing a dissertation therefore requires some thought, planning and organisation. The B.Sc. (Hon) thesis in CUTN be between 5,000 to 10,000 words. Students are expected to follow a prescribed format. Students is generally expected work closely with a faculty member, who will guide them in developing systematically a research topic, the tools and methodology for data collection, and the analytical framework for writing the dissertation. A Systematic timeline is to be maintained in completing the Research Dissertation.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓

SEMESTER – VIII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5082	**Research Methodology and Publication Ethics**	**4**	**-**	**4**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	demonstrate knowledge of research processes (reading, evaluating, and developing), and perform literature reviews using print and online databases.	Understand
CO2	identify, explain, compare, and prepare the key elements of a research proposal/report.	Analyze
CO3	describe sampling methods, measurement scales and instruments, and appropriate uses of each. Conduct multivariate inferential data analysis	Apply
CO4	understand to write the report, dissertation and manuscript	Skill

b. Syllabus

Units	Content	Hrs.
I	Meaning, concept, types and characteristics of research, scientific inquiry, Philosophical and Sociological foundations of research. Qualitative and quantitative methods of research. Characteristics of methods and their implications in the research area.	12
II	Research proposal and its elements, Formulation of Hypothesis, Literature Survey, Identification of Problem, Development of objectives and characteristics of objectives, Reference collection. Use of Libraries and Information Retrieval systems, Internet Browsing – assessing the current status.	12
III	Concept of sampling and other concepts related to sampling. Probability and non-probability samples, their characteristics and implications. Tools of data collections, their types, attributes and uses. Analysis of quantitative data and its presentation with tables, graphs etc.	12
IV	Principles of report writing and guidelines according to style manuals, Writing and presentation of preliminary, main body and reference section of report, Evaluation of research report. Scientific writing – Characteristics. Logical format for writing thesis and papers. Guidelines according to style manuals (Title, Abstract, Introduction, Literature Review, Materials and Methods, Result and Discussion and Conclusion)	12

V	Definition of Research Ethics; Confidentiality in maintaining the analysis data, scientific misconduct in research practices, essential ethical principle for research students, plagiarism, falsification, fabrication, redundant publications, selective reporting and misinterpretation of data, journal finders	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Kothari, C.R. (2005) Quantitative Technique, Vikas Publication House, New Delhi.
2. Gautam, N.C. (2004) Development of Research tools, Shree Publishers, New Delhi.
3. Gupta Santosh (2005) Research Methodology and Statistical Techniques, Deep and Deep Publications.Uddin, N., &Ang, A. H. (2011). Quantitative risk assessment (QRA) for natural hazards. Amer
4. Williams H Roy. Earth Science New Methods and Studies (2021). (Eds) Apple Academic Press. ISBN 9781774631874

Reference Books

1. Below, Christian Tiberius, Hans van der Marel, René Reudink & Freek van Leijen (2021) Surveying and Mapping. Publisher: TU Delft OPENTU Delft Open TextbookDelft University of Technology — The Netherlands. ISBN (e-book): 978-94-6366-489-9. DOI: https://doi.org/10.5074/T.2021.007.
2. Panneerselvam, R., Research Methodology, Prentice Hall of India, New Delhi.
3. Sharon Lohr, “Sampling: Design and Analysis” Duxbury Press

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓			✓	✓
CO2	✓		✓		✓	✓
CO3	✓		✓	✓		
CO4		✓			✓	

SEMESTER - VIII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5083	**Global Climate Change**	**4**	**-**	**4**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the various factors responsible for climate change	Understand
CO2	explain mechanism and causes of natural climate change	Analyze
CO3	describe millennial-scale climate change	Apply
CO4	distinguish natural versus anthropogenic climate changes	Skill

b. Syllabus

Units	Content	Hrs.
I	Framework of climate science: Overview of climate science; Heat transfer in the ocean and atmosphere, ice and biosphere; Climate archives, data, and models	12
II	Tectonic-scale climate change: CO_2 and long-term climate; Plate tectonics and long-term climate; Greenhouse and icehouse climate during the Earth's history	12
III	Orbital-scale climate change: Astronomical control on solar radiation; Insolation grip on monsoon and ice sheets; Orbital-scale changes in carbon dioxide and methane	12
IV	Millennial-scale climate change: Millennial oscillations in ice and marine sediment cores; Dansgaard-Oeschger and Heinrich events; Mechanisms of millennial oscillations; Last Glacial Maximum and deglaciation; The Holocene	12
V	Global warming: Anthropogenic carbon dioxide, Warming climate, An introduction to Intergovernmental Panel on Climate Change (IPCC) and an overview of IPCC report(s); IPCC recommendations; Future climate change and uncertainties	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars

- Class Tests
- Group discussion / Quiz

Text Books

1. Ruddiman, W.F., (2008), Earth's climate: Past and Future, W.H. Freeman & Son.
2. Bradley, R.S., (2013), Paleoclimatology: Reconstructing Climates of the Quaternary, Academic Press.
3. Crowley, T.J. & North, G.R. (1996), Paleoclimatology, Oxford University Press.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓			✓
CO2	✓	✓	✓	✓		
CO3			✓	✓	✓	✓
CO4	✓			✓		✓

B.Sc. Hons with Research - Degree

SEMESTER - VIII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5084	**Research Project**	**-**	**-**	**12**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	gain a deeper level of understanding in the chosen area of research, together with the knowledge of past work in that area and learning to carry out a research project, is a significant objective.	Analyze
CO2	develop and evaluate the theoretical and empirical positioning of the selected topic.	Apply
CO3	conduct research in a topic in a methodologically sound way and write up the results and analysis in a dissertation with a logical structure that considers the evidence in systematic and even creative way.	Create

Content	Weeks
Research is a quest for knowledge, or a systematic investigation, with an openness, and the aim may be to establish novel facts, solve new or existing problems, prove new relationships or develop new theories or explore and establish inter-relationships. The research dissertation offers Masters' students the opportunity to produce work of originality and to contribute to knowledge in the field of Geology. Students will gain hands-on experience in conceptualising and conducting a formal research project including collecting, analysing and interpreting data and writing a publishable quality dissertation. Thus, this component will provide students an opportunity to engage with research methodology through direct and active involvement in conducting a research study. The dissertation will also enable students to utilise and integrate knowledge gained from course work in the B.Sc. (Hon) with research programme and either extend this knowledge or apply it in a relevant manner further explore an issue, a problem or an area of inquiry. The research is expected to contribute to influencing policies, building theory for improving practice, and possible applications of the knowledge gained. The outcome of research may be new knowledge leading to improved understanding of the world around us and the development of new and improved procedures or establishing sharper relationship between factor or issues. To ensure that research results are shared, it must be disseminated in an appropriate manner. In many ways, the dissemination of the research results is just as important as the	18

research activity itself. There are many ways to disseminate research results, and the production of a research dissertation is one of them. A research dissertation contains elements which distinguish it from other types of reports and documentation. Because it is the culmination of several months of work, the written document can be quite voluminous. Writing a dissertation therefore requires some thought, planning and organisation. The B.Sc. (Hon) with research thesis in CUTN be between 5,000 to 15,000 words. Students are expected to follow a prescribed format. Students is generally expected work closely with a faculty member, who will guide them in developing systematically a research topic, the tools and methodology for data collection, and the analytical framework for writing the dissertation. A Systematic timeline is to be maintained in completing the Research Dissertation.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓

SEMESTER – VIII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5082	**Research Methodology and Publication Ethics**	**4**	**-**	**4**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	**Level**
CO1	demonstrate knowledge of research processes (reading, evaluating, and developing), and perform literature reviews using print and online databases.	Understand
CO2	identify, explain, compare, and prepare the key elements of a research proposal/report.	Analyze
CO3	describe sampling methods, measurement scales and instruments, and appropriate uses of each. Conduct multivariate inferential data analysis	Apply
CO4	write the report, dissertation and manuscript	Skill

b. Syllabus

Units	**Content**	**Hrs.**
I	Meaning, concept, types and characteristics of research, scientific inquiry, Philosophical and Sociological foundations of research. Qualitative and quantitative methods of research. Characteristics of methods and their implications in the research area.	12
II	Research proposal and its elements, Formulation of Hypothesis, Literature Survey, Identification of Problem, Development of objectives and characteristics of objectives, Reference collection. Use of Libraries and Information Retrieval systems, Internet Browsing – assessing the current status.	12
III	Concept of sampling and other concepts related to sampling. Probability and non-probability samples, their characteristics and implications. Tools of data collections, their types, attributes and uses. Analysis of quantitative data and its presentation with tables, graphs etc.	12
IV	Principles of report writing and guidelines according to style manuals, Writing and presentation of preliminary, main body and reference section of report, Evaluation of research report. Scientific writing – Characteristics. Logical format for writing thesis and papers. Guidelines according to style manuals (Title, Abstract, Introduction, Literature Review, Materials and Methods, Result and Discussion and Conclusion)	12

V	Definition of Research Ethics; Confidentiality in maintaining the analysis data, scientific misconduct in research practices, essential ethical principle for research students, plagiarism, falsification, fabrication, redundant publications, selective reporting and misinterpretation of data, journal finders	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Kothari, C.R. (2005) Quantitative Technique, Vikas Publication House, New Delhi.
2. Gautam, N.C. (2004) Development of Research tools, Shree Publishers, New Delhi.
3. Gupta Santosh (2005) Research Methodology and Statistical Techniques, Deep and Deep Publications.Uddin, N., &Ang, A. H. (2011). Quantitative risk assessment (QRA) for natural hazards. Amer
4. Williams H Roy. Earth Science New Methods and Studies (2021). (Eds) Apple Academic Press. ISBN 9781774631874

Reference Books

1. Below, Christian Tiberius, Hans van der Marel, René Reudink & Freek van Leijen (2021) Surveying and Mapping. Publisher: TU Delft OPENTU Delft Open TextbookDelft University of Technology — The Netherlands. ISBN (e-book): 978-94-6366-489-9. DOI: https://doi.org/10.5074/T.2021.007.
2. Panneerselvam, R., Research Methodology, Prentice Hall of India, New Delhi.
3. Sharon Lohr, “Sampling: Design and Analysis” Duxbury Press

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓			✓	✓
CO2	✓		✓		✓	✓
CO3	✓		✓	✓		
CO4		✓			✓	✓

SEMESTER - VIII				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLYEC04	**Global Climate Change**	**4**	**-**	**4**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the various factors responsible for climate change	Understand
CO2	explain mechanism and causes of natural climate change	Analyze
CO3	describe millennial-scale climate change	Apply
CO4	distinguish natural versus anthropogenic climate changes	Skill

b. Syllabus

Units	Content	Hrs.
I	Framework of climate science: Overview of climate science; Heat transfer in the ocean and atmosphere, ice and biosphere; Climate archives, data, and models	12
II	Tectonic-scale climate change: CO_2 and long-term climate; Plate tectonics and long-term climate; Greenhouse and icehouse climate during the Earth's history	12
III	Orbital-scale climate change: Astronomical control on solar radiation; Insolation grip on monsoon and ice sheets; Orbital-scale changes in carbon dioxide and methane	12
IV	Millennial-scale climate change: Millennial oscillations in ice and marine sediment cores; Dansgaard-Oeschger and Heinrich events; Mechanisms of millennial oscillations; Last Glacial Maximum and deglaciation; The Holocene	12
V	Global warming: Anthropogenic carbon dioxide, Warming climate, An introduction to Intergovernmental Panel on Climate Change (IPCC) and an overview of IPCC report(s); IPCC recommendations; Future climate change and uncertainties	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars

- Class Tests
- Group discussion / Quiz

Text Books

1. Ruddiman, W.F., (2008), Earth's climate: Past and Future, W.H. Freeman & Son.
2. Bradley, R.S., (2013), Paleoclimatology: Reconstructing Climates of the Quaternary, Academic Press.
3. Crowley, T.J. & North, G.R. (1996), Paleoclimatology, Oxford University Press.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓			✓
CO2	✓	✓	✓	✓		
CO3			✓	✓	✓	✓
CO4		✓		✓	✓	

Minor courses

SEMESTER - II				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5011	**Introduction to Geology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	explain Earth's origin, internal structure, plate tectonics, and geological time	Understand
CO2	identify landforms produced by weathering and geological agents	Apply
CO3	explain the tools that geologists use to identify and classify minerals and rocks	Apply

b. Syllabus

Units	Content	Hrs.
I	Definition and scope of geology, various branches of geology; origin of the Universe; Big Bang Theory; Origin of the Solar System and its planets; Nebular hypothesis; Classification of planets -The terrestrial and Jovian planets; Meteorites and Asteroids. Mechanical and chemical layering of the Earth.	9
II	Concept of Geological time- Relative age and absolute age; principles used to determine the relative age; Geological time scale; isotope dating; Age of the Earth	9
III	Concept of plate tectonics, sea-floor spreading and continental drift; Different types of plate boundaries- Convergent boundary, divergent boundary and transform faults; Distribution of Earthquake and volcanoes and their relationship with plate boundaries.	9
IV	Introduction to Geomorphology; Weathering: physical, chemical, and biological weathering; Geological agents and landforms: Fluvial processes and river landforms, Glacial processes and glacial landforms, Aeolian processes and desert landforms, Coastal processes and coastal landforms	9
V	Element distribution in the Earth's crust, definition of minerals, physical properties of minerals, classification of minerals, industrial applications of minerals, Classification of rocks: igneous, sedimentary, metamorphic; Rock cycle and its significance	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Grotzinger, J., & Jordan, T. H. (2010). Understanding earth. Macmillan.
2. Plummer, C. C., Carlson, D., & Hammersley, L. (2016). Physical geology. McGraw-Hill/Education.
3. Skinner, B. J., & Porter, S. C. (1995). The blue planet: an introduction to earth system science. New York: John Wiley.

Reference Books

1. Marshak, S. (2011). Earth: Portrait of a planet: Fourth international student edition. WW Norton & Company.
2. Klein, C., & Philpotts, A. R. (2013). Earth materials: introduction to mineralogy and petrology. Cambridge University Press.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓		✓	✓
CO2	✓		✓	✓	✓	✓
CO3		✓	✓	✓		✓

SEMESTER – II				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5012	**Geology (Practical-1)**	**-**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	read maps and explain signs and symbols	Analyze
CO2	use magnetic compass; identify relief forms based on contour pattern	Apply

b. Syllabus

Units	Content	Hrs.
I	Basics of maps: Definition and types of maps: topographic, thematic, geological and drainage maps; Use of different types of maps; Map elements: title, legend, north arrow, scale, grid, marginal information, index; and map accuracy. Geographic coordinates: latitude, longitude, locating points using coordinates and grid references.	12
II	Toposheets reading: scale series, symbols and conventional signs (roads, settlements, vegetation, drainage, boundaries, benchmarks, spot heights); Numbering scheme for Indian topographic maps: million sheet, degree sheet, quadrant sheet, and toposheet.	12
III	Map scale: graphical, verbal and representative fraction; conversion between scales; concept of large-scale vs small-scale maps with simple numerical problems relating map and ground distance; Measurement of distance and area on maps: use of scale, dividers, string method, grid counting; pace approximation and field estimation of distance.	12
IV	Contours: definition, contour interval, index contours; rules of contouring; interpretation of relief forms based on contour pattern (ridges, valleys, spurs, escarpments, passes, conical hills, plains); Geological maps: Components of geological map; Basic structural symbols: strike and dip notation, fold axes;	12
V	Magnetic compass: Introduction to magnetic compass, its components; Field use of maps: orienting toposheets in the field, Simple interpretation of geological maps: identifying outcrop patterns of horizontal, and dipping beds; construction of structural contour, preparation of simple geological maps with three-point problems.	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Text Books

1. Robinson, A., Morrison, J.L., Muehrcke, P.C., Kimerling, A.J. and Guptill, S.C. (2011). Elements of Cartography. 6th edition. New York: Wiley.
2. Singh, G. (2004). Map Work and Practical Geography. Delhi: Vikas Publication House.
3. Singh, R.L. and Singh, R.P.B. (2003). Elements of Practical Geography. New Delhi: Kalyani Publishers.
4. Billings, M. P., (1987), Structural Geology, 4th edition, Prentice-Hall.
5. Lisle, R.J., (2004), Geological Structures and Maps: A Practical Guide, Third Edition. Elsevier
6. Edgar W. Spencer, (2018). Geologic Maps: A Practical Guide to Preparation and Interpretation, Third Edition, Waveland Press, Inc.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓	✓		✓	✓	✓

SEMESTER - II				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5021	**Petrology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Understand the basic concepts, classification, formation, textures, and structures of igneous, sedimentary, and metamorphic rocks.	Understand
CO2	processes of magmatism, sedimentation, and metamorphism involved in the origin and evolution of rocks.	Analyze
CO3	petrological knowledge to identify rocks and minerals and explain their geological and economic significance.	Apply

b. Syllabus

Units	Content	Hrs.
I	Definition, scope, of petrology, Rock cycle and its significance; Classification of rocks: igneous, sedimentary, and metamorphic, Rock-forming minerals: introduction and significance, basic concepts of texture and structure in rocks.	9
II	Magma: origin, composition, and types; Intrusive and extrusive igneous rocks; Forms of igneous bodies; Textures and structures of igneous rocks; Classification of igneous rocks; Bowen's Reaction Series and its significance; description and occurrence of common igneous rocks.	9
III	Definition, scope, and importance of sedimentary petrology; Process of formation of sedimentary rocks, rock cycle, weathering, erosion, transportation, and deposition; Formation and classification of sedimentary rocks; Sedimentary textures and structures; Clastic, chemical, and organic sedimentary rocks; Description and occurrence of common sedimentary rocks.	9
IV	Definition and scope of metamorphism; agents of metamorphism; types of metamorphism: contact, regional, dynamic, cataclastic, burial and hydrothermal, metamorphic textures and structures; metamorphic grade and zones; concept of metamorphic facies; Foliated and non-foliated metamorphic rocks; Description and occurrence of common metamorphic rocks.	9
V	Origin and evolution of igneous rocks; Sedimentary cycle and basin formation; Metamorphic differentiation and recrystallization; Geological significance of rocks; Economic importance of igneous, sedimentary, and metamorphic rocks; applications of petrology in geology and engineering	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Bangar, K. M., 2005, Principles of engineering geology, Standard Publishers Distributors.
2. Best, M.G. (2003). Igneous and Metamorphic Petrology (2nd Edition). Blackwell Publishing, Oxford.
3. Boggs, S., (1995), Principles of Sedimentology and Stratigraphy. Print ice Hall, New Jersey.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓		✓	
CO2	✓	✓	✓	✓		✓
CO3	✓	✓		✓	✓	✓

SEMESTER – II				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5022	**Petrology (Practical)**	**-**	**2**	**2**

d. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	identify and describe common rock-forming minerals and igneous, sedimentary, and metamorphic rocks using their megascopic properties, textures, and structures.	Understand
CO2	apply basic petrographic methods for rock description, thin-section observation, specimen labelling, and maintenance of practical records.	Apply

e. Syllabus

Units	Content	Hrs.
I	Study and identify common rock-forming minerals such as quartz, feldspar, mica, hornblende, augite, olivine, and calcite using physical properties including colour, lustre, hardness, cleavage, fracture, and streak.	12
II	Megascopically-identify and describe common igneous rocks including granite, basalt, gabbro, diorite, rhyolite, and dolerite; the study of igneous textures, structures, grain size, and mineral composition.	12
III	Megascopic study and description of sedimentary rocks such as sandstone, shale, limestone, conglomerate, breccia, and chert; sedimentary textures, structures, grain size, sorting, and other diagnostic features.	12
IV	Study and identify common metamorphic rocks including slate, phyllite, schist, gneiss, marble, and quartzite; metamorphic textures, foliation, lineation, and recrystallization features.	12
V	Introduction to the petrographic microscope and the basic methods of petrographic observation through demonstration of thin sections; preparation of systematic rock description sheets, specimen labelling, and maintenance of practical record books.	12

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Records / viva-voce
- Class Tests

Text Books

1. Bangar, K. M., 2005. Principles of engineering geology, Standard Publishers Distributors.
2. Best, M.G. (2003). Igneous and Metamorphic Petrology (2nd Edition). Blackwell Publishing, Oxford.
3. Boggs, S., (1995). Principles of Sedimentology and Stratigraphy. Print ice Hall, New Jersey

f. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓		✓	✓		✓

SEMESTER - III				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY5033	**Application of Geology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the fundamental principles and applications of geophysics, geochemistry	Understand
CO2	analyze geological, geophysical, and geochemical data for solving environmental and engineering problems.	Analyze
CO3	apply geological knowledge in resource exploration, environmental management, and sustainable development.	Apply

b. Syllabus

Units	Content	Hrs.
I	Introduction to geophysics; physical properties of the Earth; seismic waves, gravity, magnetism, geothermal gradients, and electrical properties of rocks; Basic principles and applications of seismic, gravity, magnetic, electrical, and resistivity methods.	9
II	Chemical composition of the Earth; distribution of elements in the crust, mantle, and core; atomic structure, geochemical classification of elements, geochemical cycles; weathering processes, mobility of elements; significance of trace elements and isotopes in geological studies.	9
III	Introduction to environmental geology; natural resources and environmental hazards; environmental pollution, groundwater contamination, soil erosion, desertification, waste disposal, and climate change.	9
IV	Introduction to engineering geology; engineering properties of rocks and soils, geological investigations for dams, tunnels, bridges, highways, and reservoirs.	9
V	Practical applications of geophysics, geochemistry, environmental geology, and engineering geology in resource exploration and environmental studies.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussion / Quiz

Text Books

1. Bangar, K. M., 2005, Principles of engineering geology, Standard Publishers Distributors.
2. Kearey, P., Brooks, M., & Hill, I. (2002). An introduction to geophysical exploration (3rd ed.). Blackwell Science.
3. Mason, B., & Moore, C. B. (1982). Principles of geochemistry (4th ed.). Wiley.
4. Keller, E. A. (2011). Environmental geology (9th ed.). Pearson Education.
5. Montgomery, C. W. (2012). Environmental geology (10th ed.). McGraw-Hill.
6. Parbin Singh. (2010). Engineering and general geology (8th ed.). Katson Publishing House.
7. Holmes, A. (1993). Principles of physical geology. Chapman & Hall.
8. Tarbuck, E. J., Lutgens, F. K., & Tasa, D. (2014). Earth science (14th ed.). Pearson Education.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓		✓	
CO2		✓	✓	✓		✓
CO3	✓	✓		✓	✓	✓

Open Elective Courses

SEMESTER – I				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLYOEU1	**Basic Geology and Earth Sciences**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the scope of Geology and its relation with allied sciences	Understand
CO2	describe the origin of the universe and Solar System and explain the components and interactions of the Earth systems.	Analyze
CO3	explain geological time scale and understand the occurrence and importance of energy minerals	Apply

b. Syllabus

Units	Content	Hrs.
I	Earth, its materials, structure, processes, and history. Scope and branches of geology and its relationship with allied sciences such as physics, chemistry, biology, geography, and environmental science.	9
II	Origin of the universe; formation of the Solar System; nebular hypothesis; study of the solar System; divisions of sun; solar phenomena; solar effects; the planers; the earth; shape, size, age, and density of the Earth.	9
III	Concept of the Earth System and the interaction among the lithosphere, atmosphere, hydrosphere, and biosphere; the crust, mantle, and core along with their composition and characteristics; atmosphere, its composition, and different layers; hydrosphere and its components including oceans, rivers, lakes, glaciers, and groundwater.	9
IV	Fossils, their nature, formation, and significance in geological studies; different fossilization processes; importance of fossils in determining geological age, correlating rock layers, understanding past environments, and studying the evolution of life; evolution of life through the geological time scale.	9
V	Occurrence, distribution, and importance of mineral and energy resources; formation, occurrence, and uses of coal and petroleum as major fossil fuels; Groundwater occurrence, movement, storage in aquifers, and its importance.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests

Text Books

1. Bangar, K. M., 2005, Principles of engineering geology, Standard Publishers Distributors.
2. Carlson, D. and Plummer, C. C., 2008, Physical Geology, McGraw- Hill.
3. Davies, G.F. (1999). Dynamic Earth: Plates, Plumes and Mantle Convection. Cambridge University Press.
4. Mahapatra, G. B., 2019, A Textbook of Geology, CBS (1 January 2019)

Reference Books

1. Duff, P. M. D., & Duff, D. (Eds.)., 1993, Holmes' principles of physical geology, Taylor & Francis
2. Bateman, A.M. and Jensen, M.L. (1981). Economic Mineral Deposits (3rd Edition). John Wiley and Sons, New York.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓				✓
CO2		✓	✓		✓	✓
CO3	✓	✓	✓	✓	✓	

SEMESTER - II				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLYOEU2	**Essentials of Geology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the fundamental concepts of geology and Earth processes.	Understand
CO2	explain basic geological structures and their significance.	Analyze
CO3	describe the importance of economic minerals.	Apply

b. Syllabus

Units	Content	Hrs.
I	Introduction to geology and branches of geology; age of the earth; Geological action of rivers, wind, glaciers, and groundwater; landforms and geomorphic processes; earthquakes and volcanoes.	9
II	Petrology and mineralogy: Definition of minerals; Minerals in daily life: common minerals used in industries; how to identify them by color and hardness. Definition and classification of rocks; The Rock Cycle: Simplified origin of Igneous (volcanic), Sedimentary (layered), and Metamorphic (transformed) rocks.	9
III	Structural geology: Introduction to structural geology; Attitude of beds: strike and dip; description of folds; nomenclature and recognition of folds and their types; Faults; repetition and omission of strata; normal fault; reverse fault and strike slip fault; joints and its classification.	9
IV	Stratigraphy: fundamental concepts and principles of stratigraphy; Earth history; superposition, original horizontality, lateral continuity, and faunal succession; geological time scale and major divisions of geological time; classification and correlation of rock strata; unconformities and their types; introduction to Indian stratigraphy.	9
V	Economic geology: Introduction to economic geology; Definition of ore, and gangue minerals; Metallic and Non-Metallic minerals: occurrence and their uses.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussions

Text Books

1. Bangar, K. M., 2005, Principles of engineering geology, Standard Publishers Distributors.
2. Holmes, A. (1978). Principles of Physical Geology (3rd Edition). Chapman and Hall, London.
3. Nesse, W.D. (2012). Introduction to Mineralogy (2nd Edition). Oxford University Press, New York.
4. Best, M.G. (2003). Igneous and Metamorphic Petrology (2nd Edition). Blackwell Publishing, Oxford.
5. Billings, M.P. (1972). Structural Geology (3rd Edition). Prentice Hall of India Pvt. Ltd., New Delhi.
6. Mahapatra, G.B., 2001. A text book of Geology. CBS publishers and distributors, New Delhi.

Reference books

1. Bateman, A.M. and Jensen, M.L. (1981). Economic Mineral Deposits (3rd Edition). John Wiley and Sons, New York.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓		✓	✓	✓
CO2	✓		✓		✓	✓
CO3	✓	✓	✓	✓		

SEMESTER - III				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLYOEU3	**Introduction to petrology**	**3**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	understand the basic concepts, scope, and importance of petrology in geology	Understand
CO2	explain the origin and characteristics of igneous rocks and magmatic processes.	Analyze
CO3	describe the formation of sedimentary and metamorphic rocks and their importance.	Apply

b. Syllabus

Units	Content	Hrs.
I	Definition, scope, and branches of petrology, Rock cycle and its significance; classification of rocks: igneous, sedimentary, and metamorphic, Rock-forming minerals: introduction and significance.	9
II	origin, composition, and types of igneous rocks; intrusive and extrusive igneous rocks; forms of igneous bodies; textures and structures of igneous rocks; Classification of igneous rocks; occurrence of common igneous rocks.	9
III	Definition, scope, of sedimentary rocks: process of formation of sedimentary rocks, weathering, erosion, transportation, and deposition; classification of sedimentary rocks; clastic, chemical, and organic sedimentary rocks; origin of different sedimentary structures.	9
IV	Definition and scope of metamorphic rocks: Types of metamorphism: contact, regional, dynamic, cataclastic, burial and hydrothermal, Metamorphic grade and facies; occurrence of common metamorphic rocks.	9
V	Origin and importance of rocks; economic importance of igneous, sedimentary, and metamorphic rocks; uses of rocks in construction and industries; applications of petrology in geology and engineering.	9

Tasks and Assignments:

Each student is required to undergo the following:

- Assignments
- Seminars
- Class Tests
- Group discussions

Text Books

1. Bangar, K. M., 2005, Principles of engineering geology, Standard Publishers Distributors.
2. Best, M.G. (2003). Igneous and Metamorphic Petrology (2nd Edition). Blackwell Publishing, Oxford.
3. Boggs, S., (1995), Principles of Sedimentology and Stratigraphy. Print ice Hall, New Jersey.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓		✓	✓
CO2		✓		✓		✓
CO3	✓		✓	✓		