தமிழ்நாடு மத்தியப் பல்கலைக்கழகம்

CENTRAL UNIVERSITY OF TAMIL NADU

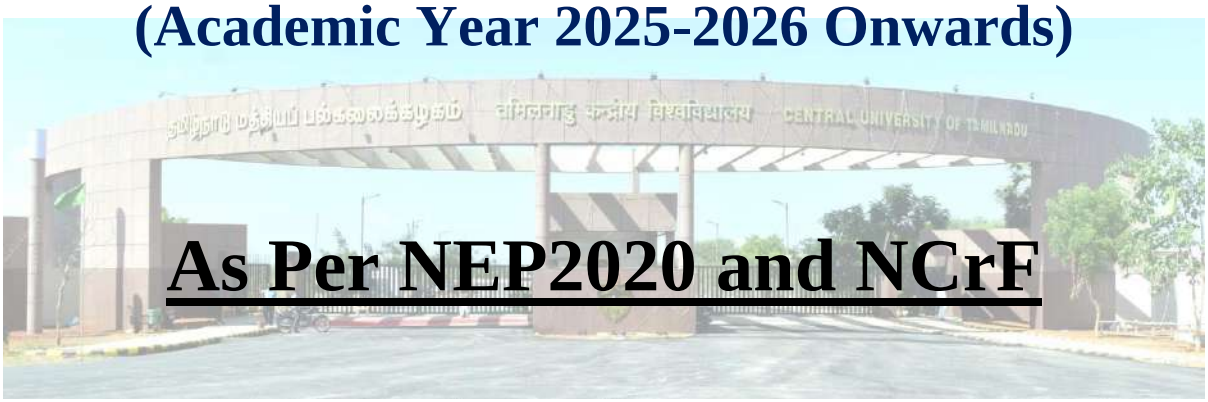
तमिलनाडु केन्द्रीय विश्वविद्यालय

ESTABLISHED BY AN ACT OF PARLIAMENT IN 2009

M.Sc. Applied Geology Programme

Curriculum Structure

(Academic Year 2025-2026 Onwards)



As Per NEP2020 and NCrF

Department of Geology

School of Earth Sciences

Central University of Tamil Nadu

Neelakudi, Thiruvarur-610005

Email: hodgeology@cutn.ac.in

Table of Content

A. Vision

To produce and sustain the conditions that enables the students to experience the transformative learning in becoming an independent and ideal learner through 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.

B. Mission

M1 To provide 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

C. Program Educational Objectives (PEO)

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

PEO1 To provide knowledge in geology and their applications

PEO2 To develop analytical and logical aptitude amongst students to adapt quickly to new work environments, assimilate further information and problem-solving ability

PEO3 To provide exposure to new technologies to the students and motivate them to take new challenges

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

D. Post-Graduate Attributes for Applied 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

E. PEO to Mission Statement Mapping

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

F. Program Outcomes (PO)

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, analyse, 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 analyse complex problems reaching substantiated conclusions

G. PO to PEO Mapping

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

H. Programme Structure

Semester	Courses			Credits			Assessment	
	Code	Title		L	P	Total	CIA	ESE
	First Year							
I	GLY2011	Physical Geology and Geomorphology		3		3	40	60
I	GLY2012	Structural Geology and Tectonics		3		3	40	60
I	GLY2013	Mineralogy and Crystallography		4		4	40	60
I	GLY2014	Geochemistry and Isotope Geology		3		3	40	60
I	GLY2015	Economic Geology and Ore Genesis		3		3	40	60
I	GLY2016	Structural Geology and Tectonics **(Practical)**			2	2	100*	
I	GLY2017	Mineralogy and Crystallography **(Practical)**			2	2	100*	
I	GLY2018	Geochemistry and Economic Geology **(Practical)**			2	2	100*	
			Total			**22**	**800**	
Semester	**First Year**							
II	GLY2021	Igneous Petrology		3		3	40	60
II	GLY2022	Metamorphic Petrology		3		3	40	60
II	GLY2023	Remote Sensing and GIS		4		4	40	60
II	GLY2024	Geophysics and Exploration Geology		4		4	40	60
II	GLY2027	Oceanography and Marine Geology		3		3	40	60
II	GLY2025	Igneous and Metamorphic Petrology **(Practical)**			2	2	100*	
II	GLY2026	Remote Sensing and GIS **(Practical)**			2	2	100*	
II	Open Elective (OE)	Open Elective Course from the other Department/s of CUTN		3		3	40	60
II	GLYVA01	Introduction to Atmospheric Science	Any One	2		2	40$^{\$}$	60$^{\$}$
	GLYVA02	Introduction to Climate Science						
	GLYVA03	Introduction to Planetary Science						
	GLYVA04	Hyperspectral Remote Sensing						
II	GLY4021	Internship / Industrial Training			2	2	100$^{@}$	
			Total			**24/26**$^{@}$	**800/900**$^{@}$	

NCrF Level 6.5 first year total credit points: 46 x 6.5 = 299 (for Master's degree after obtaining their 3 years bachelor degree).
NCrF Level 6 first year total credit points: 48 x 6.0 = 288 (for PG Diploma after obtaining their 3 years bachelor degree / 2 semester of the 2-year master's degree).

Semester	Courses			Credits			Assessment	
	Code	Title		L	P	Total	CIA	ESE
	Second Year							
III	GLY2031	Palaeontology		3		3	40	60
III	GLY2032	Sedimentology		3		3	40	60
III	GLY2033	Stratigraphy		3		3	40	60
III	GLY2034	Hydrogeology and Sustainable Development		3		3	40	60
III	GLY2035	Fuel Geology		3		3	40	60
III	GLY2036	Sedimentology and Paleontology **(Practical)**			2	2	100*	
III	GLY2037	Hydrogeology and Fuel Geology **(Practical)**			2	2	100*	
III	GLYSE01	Geostatistics and Computer Applications **(Skill Enhancement Course)**		2		2	40	60
III	GLYEC04	Mining Geology	Any One	3		3	40	60
	GLYEC05	Engineering Geology						
	GLYEC06	Medical Geology and Society						
			Total			**24**	**900**	
Semester	**Second Year**							
IV	GLY2041	Dissertation				12	100	
IV	GLY2042	Geological Field Study				4	100[#]	
IV	GLY2043	Research Methodology				3	100	
IV	As per MOOC list	Remote Sensing for Natural Hazard Studies	[β]MOOC			3	100[α]	
IV		Earthquake Geology: A Tool for Seismic Hazard Assessment						
IV		Environmental Science						
IV		Climate Change – Extreme Events						
IV		Disaster Risks Reduction and Management						
IV		Climate Risk, Adaptation and Sustainable Development						
IV		Other NPTEL/Swayam courses						
			Total			**22**	**400**	
			Grand Total			**92+**	**2900 +**	

L: Lecture	P: Practical
CIA: Continuous Internal Assessment	ESE: End Semester Examination
EC: Elective Course	OE: Open Elective
VC: Value added Course	SE: Skill Enhancement Course
*: Continuous Evaluation;	[$]: Marks will not be added in CGPA
[@]: Mandatory for PG Diploma Students	[#]: Course for III and IV semester and marks reflect on IV semester

[α]: This course placed in the IV[th] semester but students can register a MOOC course any semester from 1[st] to 2[nd] Year of their PG Programme

[β]: Course(s) to be chosen from the list of available courses after due discussion with the faculty members of the department.

NCrF Level 6.5 first year total credit points: 46 x 6.5 = 299 (for Master's degree after obtaining their 4 years bachelor degree / second year of master's degree).

NCrF Level 6.5 Master's degree programme: 92 x 6.5 = 598 credits points

I. Common Evaluation Scheme for all the courses

- **Theory course**

	Unit-I	Unit-II	Unit-III	Unit-IV	Unit-V	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

- **Practical course**

	Unit-I	Unit-II	Unit-III	Unit-IV	Unit-V	Total
Continuous Assessment	20	20	20	20	20	100
Total	**20**	**20**	**20**	**20**	**20**	**100**

J. Internal Assessment (40 Marks)

- **Theory course**

	Marks
Assignments/ Seminar/ Attendance/ Test	20
Test	20
Total	**40**

K. External Assessment (60 Marks)

- **Theory course**

Category	Marks
Part – A (Objective - 10 x 1 = 10 marks)	10
Part – B (Short Answer - 5 x 3 = 15 marks)	15
Part – C (Long Answer - 5 x 7 = 35marks)	35
Total	**60**

- **Practical course (Continuous Assessment)**

	Marks
Laboratory Report/ Assignments	75
Viva/Test	20
Attendance and Class Interaction	5
Total	**100**

L. Common Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content** **50%**	Ideas are detailed, well developed, supported with specific evidence & facts and examples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported.	Content is not sound	Not attended	CO1, CO2, CO3, CO4
2	**Organization** **50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO3, CO4

M. Common Rubric for Seminar

Sl. No	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO1, CO2, CO3, CO4
2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunicat-ion	Not Attended	CO1, CO2, CO3, CO4

N. Common Model Question Paper

Part A **[10 x 1= 10]**

(Objective type: multiple choice, fill in the blanks, one word answer)
*Answer **ALL the questions**. Each Question carries one mark.*

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

Part B **[5 x 3= 15]**

(Short answer type: answer should not exceed 200 words)
*Answer **ALL the questions**. Each Question carries three marks.*

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

Part C **[5 x 7 = 35]**

(Essay answer type: answer should not exceed 400 words)
*Answer **ALL the** questions. Each Question carries seven marks.*

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)

Semester-I

O. SEMESTERWISE COURSE CONTENT

SEMESTER - I				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2011	Physical Geology and Geomorphology	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 Earth processes and features	Understand
CO2	Analyze the geomorphological process and their characteristics	Analyze
CO3	Knowledge of geomorphology of India and application of geomorphology in various studies	Apply

b. Syllabus

Units	**Content**	**Hrs.**
I	Solar system; origin of the earth: nebular hypothesis, planetesimal hypothesis, gaseous tidal hypothesis. binary star hypothesis; age of the earth: direct and indirect methods; interior of the earth; the atmosphere, hydrosphere, lithosphere and their constituents; fundamental concepts of geomorphology; weathering: physical weathering, chemical weathering, biological weathering; soil processes: soil profile, climate and soil formation, soil types; mass wasting: soil creep and solifluction, earth and mud flows and slides; karst topography and speleology, slope and catchment erosion processes.	9
II	An elementary idea about morphogenesis and morphography; morphometric analysis; morphochronology, neotectonics. geological time scale; geological process: exogenetic and endogenetic processes;	9
III	Landforms associated with folds and fault; fluvial geomorphology: stream erosion, transportation and deposition, stream erosional and depositional landforms, drainage systems and types of streams, stages of valley development; drainage response to climate change; glacial geomorphology: types of glaciers, movement of glaciers, glacial erosion, transport by glaciers, glacial deposits.	9
IV	aeolian geomorphology: wind erosion, erosional features, wind transport, wind deposits, types of sand deposits. coastal geomorphology: shorelines, classification of coast and shoreline, costal geomorphic processes, erosional and depositional landforms, coral reefs; geomorphic response to tectonics, sea level/base-level change, anthropogenic effects; volcanic geomorphology: types of eruption, features of lava fields, features associated with volcanoes; ash showers, volcanic mudflows or lahars, plug domes; depression forms: craters, calderas, volcanic tectonic depression; volcanic plateaus and plains;	9

V	Geomorphology of India: peninsular, extra peninsular, Indo Gangetic plain; application of geomorphology in mineral prospecting, civil engineering, military purposes, hydrogeology and environmental studies.	9

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Bloom, A., (2005), Geomorphology. Pearson. New Delhi.
2. Burbank, D. W. & Anderson, R.S., (2016), Tectonic Geomorphology. Wiley India.
3. Hamilton, E. I., (1965), Applied Geomorphology. Academic Press.
4. Holmes, A., (1992), Holmes Principles of Physical Geology Edited by P. Mcl. D. Duff. Chapman and Hall, London.
5. Sharma, H. S., (1990), Indian Geomorphology. Concept Publishing Co., New Delhi.
6. Small, R.J., (1978), Study of Landforms: A Textbook of Geomorphology (2nd Edition), Cambridge University Press.
7. Thornbury, W.D., (2002), Principles of Geomorphology, John Wiley and Sons, 2nd Edition, New York.

Reference Book

1. Condie, K. C., (1989), Plate Tectonics and Crustal Evolution. 3rd Edition. Butterworth-Heinemann Ltd.
2. Cox, A., (1973), Plate Tectonics, Freeman and Company.
3. Davies, G.F., (1999), Dynamic Earth: Plates, Plumes and Mantle Convection. Cambridge University Press.
4. Kearey P., Klepeis, K. A. & Vine, F.J., (2009), Global Tectonics 3rd Edition. Wiley-Blackwell.
5. Keller, E.A. & Pinter, N., (2001), Active Tectonics. 2nd Edition. Pearson Publications.
6. Leopold, L., Wolman, C. & Miller, J. P., (1963), Fluvial Processes in Geomorphology. Freeman.
7. Ritter, D. F., Kochel, R. C. & Miller, J. R., (2002), Process Geomorphology, Waveland press.
8. Robert, S. A. & Suzanne, P. A., (2010), Geomorphology: The mechanics and chemistry of landscapes. Cambridge University Press.
9. Russell, R.D., Jacobs, J.A. & Wilson, J.T., (1974), Physics and Geology. McGraw-Hill Inc., US.
10. Windley B., (1995), The Evolving Continents. 3rd Edition Wiley-Blackwell.

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**
GLY2012	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

Text Book

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 Book

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., (1949), Principles of structural Geology John Wiley, 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 – I				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2013	Mineralogy and Crystallography	4	-	4

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Describe the characteristics of different rock forming silicate minerals.	Evaluate
CO2	Study the key concepts of optical mineralogy	Apply
CO3	Understand the basics of crystal chemistry and crystal structure and understand the concept of symmetry elements in crystallography	Understand
CO4	Describe the functioning and application of modern analytical instruments used in mineral analysis	Analyze

b. Syllabus

Units	Content	Hrs.
I	32 crystals classes and description of the different normal classes. Different types of crystal projections – spherical and stereographic and their uses. Twinning and Twin Laws: common types of twins and their examples in minerals. Space Lattice and Symmetry of internal structures – 14 Bravais Lattice.	12
II	Introduction to space group Historical development of X-ray Crystallography Bragg's Law and its derivation. X-rays in mineral science. Application of Electron Micro Probe analyses and scanning electron Microscopy in mineral sciences.	12
III	Mineral Preparation for Microscopic study; Types of Preparation, Materials for Thin Section, The Mineral Slice and Cutting. Plane polarised and cross-polarised light; Isotropic and Anisotropic minerals; Behavior of minerals in cross-polarised light- Birefringence – Uniaxial minerals. Uniaxial and Biaxial Indicatrices; Optical accessories like mica, gypsum and quartz plates – Determination of Optic sign: uniaxial and biaxial minerals- Absorption of light by minerals – Scheme of pleochroism, crystal orientation, 2V and 2E.	12
IV	A detailed study of (concerning general and structural formulae, atomic classification structure, polymorphs/structural states, chemistry including the substitution of elements/solid solution and experimental work on pressure-temperature stability of the minerals, modes of occurrence and alterations) Nesosilicates: Olivine group, Garnet group, Aluminosilicate Group (Kyanite, Andalusite and Sillimanite). Sorosilicate: Epidote group, Ring Silicates: Tourmaline –Benitoite- Beryl.	12
V	A detailed study of (concerning general and structural formulae, atomic classification structure, polymorphs/structural states, chemistry including the	12

	substitution of elements/solid solution and experimental work on pressure-temperature stability of the minerals, modes of occurrence and alterations) Inosilicates: Pyroxene group- Amphibole group and Wollastonite, Phyllosilicates: Mica group- Chlorite group, Tectosilicates: Quartz -Feldspar group- Feldspathoid group- Zeolite and Scapolite groups, Cordierite.	

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Ford, W. E., (1932), Dana's textbook of mineralogy. CBS.
2. Nesse, W. D., (2009), Introduction to optical mineralogy. Oxford University Press, New York, USA.
3. Nesse, W.D., (2020), Introduction to Mineralogy. Oxford University Press, New York, USA.
4. Perkins, D., (2015), Mineralogy. Pearson Education India.

References

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. Kleinn, C. & Hurlbut, C. S., (1993), Manual of Mineralogy. John Wiley & Sons, INC.
4. MacKenzie, W. S., Adams, A. E. & Brodie, K. H., (2017), Rocks and Minerals in Thin Section: A Colour Atlas. CRC Press.
5. Okrusch, M. & Frimmel, H. E., (2020). Mineralogy: An introduction to minerals, rocks, and mineral deposits. Springer Nature.
6. Putnis, A., (1992), An introduction to mineral sciences. Cambridge University Press.
7. Rogers, A. F. & Kerr, P. F., (1942), Optical mineralogy (p. 390). New York: McGraw-Hill.

c. Mapping of Program Outcomes with Course Outcomes

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

SEMESTER - I				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2014	Geochemistry and Isotope 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 fundamentals of geochemistry and various geological processes associated with lithosphere and hydrosphere	Understand
CO2	Apply the basics of isotope geochemistry in the field of geochronology and petrogenesis	Apply
CO3	Explain various chemical weathering processes and its effect in the chemical composition of different types of sediments and water	Analysis

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.	9
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.	9
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 patterns, The utility of trace elements in the petrogenesis of rocks.	9
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.	9
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.	9

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

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.

References

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	✔		✔			

SEMESTER - I				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2015	Economic Geology and Ore Genesis	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

Text Book

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 Book

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 - I				
Course Code	Course Name	L	P	Credits
GLY2016	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 problems based on orthographic and stereographic projections, study of geological maps and sections	Apply
CO2	Quantification of geological strains and study of dip-isogons.	Analyze

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:

- ✔ Laboratory reports
- ✔ Assignments
- ✔ Viva

Text Book

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 Book

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 - I				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2017	Mineralogy and Crystallography **(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 rock-forming minerals at megascopic and microscopic levels.	Skill
CO2	Understand and explain the crystallography symmetry elements of 32 class	Apply

b. Syllabus

Units	Content	Hrs.
I	Megascopic identification of silicates, carbonates, oxides minerals in hand specimens.	12
II	Megascopic identification of sulfides, sulfates, halite, phosphates and native minerals in hand specimens.	12
III	Determination of length fast and length-slow characters of minerals. Scheme of pleochroism and absorption of a given mineral in thin section of silicates and opaque minerals. Determination of extinction angle and composition of plagioclase. Study of interference figures of uniaxial and biaxial crystals, determination of optic signs.	12
IV	Goniometer and its use in measuring the interfacial angle of crystals and calculation of the axial ratio, Miller index, Weiss parameter.	12
V	Representation of symmetry elements of crystals belonging to 32 classes of symmetry and study of their stereograms.	12

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Laboratory reports
- ✔ Assignments
- ✔ Viva

Text Book

1. Deer, W., Howie, R. A. & Zussman, J., (1992), An introduction to the rock-forming minerals (p. 696). Longman.
2. Nesse, W.D., (2020), Introduction to Mineralogy. Oxford University Press, New York, USA.
3. Perkins, D., (2015), Mineralogy. Pearson Education India.

References

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.
3. Potts, P.J., (2003), Handbook of Rock Analysis. Viridian Publishing, UK.

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**
GLY2018	Geochemistry and Economic 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	Familiar with various modern analytical instruments, geochemical calculations, and interpretation of geochemical results	Analyse
CO2	Identify the important ore and economic minerals.	Skill

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:

- ✔ Laboratory reports
- ✔ Assignments
- ✔ Viva

References

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-II

SEMESTER - II				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2021	Igneous 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 physical and chemical characteristics of magma and various rock types, their classification, petrogenesis and their link to tectonic settings	Understand
CO2	Understand the concept of melt generation and crystallization mechanisms	Apply
CO3	Understand the significance of igneous rocks in deciphering the Earths evolution	Apply

b. Syllabus

Units	Content	Hrs.
I	Fundamentals of Igneous petrology, differentiation of the Earth, major structural units of the Earth, energy and mantle heat engine, mantle melting mechanisms- Thermal perturbation, adiabatic uplift and volatile influx, gravity, pressure and geobaric gradient, viscosity of melts, nucleation and crystal growth, vesiculation and fragmentation of magma, igneous rock series.	9
II	Classification of magmatic rocks - based on fabric, field relations, mineralogical and modal, and whole rock compositions, IUGS classification of plutonic, hypabyssal and volcanic rocks, Irvine-Baragar classification of volcanic rocks, Intrusive & extrusive bodies associated with igneous rocks. Igneous rock textures and their genetic significance	9
III	Phase rule in igneous petrology, 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, Ternary system with solid solution- Di-An-Ab system, Ternary peritectic system- Fo-An-Qtz system. Chemical compositions and variation diagrams.	9
IV	Melt composition, mantle material, partial melting of the peridotite mantle and magma generation, alkaline magma generation, magma generation in continental crust, differentiation (open and closed systems) and assimilation, hybrid magmas, magma storage, ascent and emplacement, field relations of intrusions. Chemical fractionation, partition coefficient and trace element compatibility, rare earth elements and batch melting models, magma evolution models.	9

V	Igneous rocks of oceanic regions: Oceanic spreading ridges and related basaltic rocks, mantle plumes and oceanic island volcanic rocks, plume heads and flood basalt plateau lavas, arc magmatism, oceanic island arcs. Igneous rocks associated with convergent plate boundaries, continental flood basalt and large igneous provinces, large layered igneous complexes, continental alkaline rocks, ultra-alkaline and silica poor alkaline rocks, alkaline cratonic associations, ophiolite,, granites and continental rift associations.	9

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Anthony R. P. & Ague, J. J., (2009), Principles of Igneous and Metamorphic Petrology. Cambridge.
2. Cox, K. G., Bell, J. D. & Pankhurst, R. J., (1979), Interpretations of igneous rocks. George Allen and Unwin, London.
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

1. Gill, R., (2010), Igneous rocks and processes: a practical guide. John Wiley & Sons.
2. Hall, A., (1997), Igneous Petrology, Longman.
3. McBirney., (1994), Igneous Petrology, CBS Publishers, Delhi.
4. Ragland, P. C., (1989), Basic analytical Petrology. Oxford University Press.
5. Shelley D., (1993), Igneous and Metamorphic Rocks Under the Microscope. Chapman and Hall.
6. 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 - II				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2022	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 key concepts of chemical thermodynamics	Understand
CO2	Understand the different mechanism of metamorphism and formation of metamorphic rocks	Understand
CO3	Application of basic concepts in in metamorphic reactions, facies, and P-T-t path.	Apply

b. Syllabus

Units	**Content**	**Hrs.**
I	Closed and open systems, first law of thermodynamics, enthalpy, entropy, second and third law of thermodynamics, stability (phase) diagrams, thermodynamics of solutions.	9
II	Fugacity and activity, equilibrium constant, silica activity, silica buffers and silica saturation and, alumina saturation. Fe-Ti oxide buffers. Quantitative Geothermobarometry: Diffusion and Kinetics of metamorphic reactions.	9
III	Overview of different types of metamorphism; Textures and structures in relation to deformation and metamorphism in regional terrains; Dynamic metamorphism Processes and kinetics of thrust and fault rocks;	9
IV	Concept and classification of metamorphic facies and facies series; p-t evolution paths of metamorphic rocks. metamorphism of pelites, mafic, ultramafic and calcareous rocks; high p/t ratio metamorphism, metasomatism.	9
V	Nature of metamorphic reactions, isograds and reaction isograds, Schrienemakers rule and construction of petrogenetic grids. metamorphic differentiation, anatexis and origin of migmatites in the light of experimental studies, exhumation and uplift rates, erosion, geodynamics, and the geomorphology of metamorphic terrains.	9

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Anthony R. P. & Ague, J. J., (2009), Principles of Igneous and Metamorphic Petrology. Cambridge.
2. Mason, R., (1990), Petrology of Metamorphic Rocks, Springer, London.
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.
5. Yardley, B.W., (1989), An Introduction to Metamorphic Petrology, Cambridge University Press.

Reference Book

1. Bucher, K. & Frey, M., (1994), Petrogenesis of Metamorphic Rocks, Springer Verlag.
2. Miyashiro, A., (1994), Metamorphic Petrology, Oxford University Press.
3. Ragland, P. C., (1989), Basic analytical Petrology. Oxford University Press.
4. Shelley D., (1993), Igneous and Metamorphic Rocks Under the Microscope. Chapman and Hall.

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**
GLY2023	Remote Sensing and GIS	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 basic concepts of electromagnetic radiation, its interaction with the earth's surface and atmosphere	Understand
CO2	Study the resolution properties to interpret, process, and evaluate remotely sensed images	Apply
CO3	Remote Sensing and GIS study	Evaluate
CO4	Interpret images and mapping and the Spatial and Non spatial database	Skill

b. Syllabus

Units	**Content**	**Hrs.**
I	Introduction to remote sensing: concepts, components, electro magnetic radiation/ spectrum, theories of EMR; types of remote sensing: based on energy source and electro-magnetic spectrum. energy interaction with earth surface and atmosphere: reflection, absorption transmission, spectral signature: interaction with soil, water and vegetation and other features; scattering: Rayleigh, Mie and non-selective; absorption, and refraction; atmospheric windows.	12
II	Remote Sensing: Aerial remote sensing including UAV, and Satellite remote sensing; Indian satellite systems, Landsat satellites, SPOT, Sentinel satellites, MODIS, Japan and European satellite series and their applications; spatial, spectral and radiometric resolution of each satellite systems.	12
III	Digital image processing: radiometric correction, geometric correction, image enhancement, filters, edge enhancement, vegetation index analysis, temporal analysis, multi-image analysis, PC analysis, classification-supervised and unsupervised and methods of classification algorithms.	12
IV	GIS: Definition and Applications; Components and Elements of GIS; Development of GIS technology; theoretical models and framework for GIS, representation of geographic data; coordinate systems, Scale, resolution, map projection. Data Input, Storage and Editing: Nature of geographic data: Spatial and non-spatial data: spatial and attribute data, concept of vector and raster-based models; digitization; external databases; Data quality. Basic spatial analysis: spatial queries, neighbourhood analysis; proximity analysis	12

	and buffers; overlays analysis – raster and vector-based overlay and their applications; presentation of GIS output.	
V	Application of geoinformatics in geology- geological and geomorphological mapping; hazards mapping- flood, forest fire and landslide hazards mapping, DEM, GNSS	12

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text book

1. Campbell, J., (2002), Introduction to Remote Sensing, Taylor & Francis, London.
2. Chang, K T., (2006), Introduction to Geographic Information Systems, Tata McGraw-Hill.
3. Gupta, R.P., (2003), Remote Sensing Geology, Springer Nature Switzerland.
4. Heywood, I. Cornelius, S. & Carver, S., (2004), An Introduction to Geographic Information Systems, Pearson Education.
5. Lillesand, T. M., Kiefer, R. W. & Chipman, J. W., (2008), Remote Sensing and Image Interpretation, John Wiley & Sons, New Delhi.
6. Sabins, Floyd F. Jr., (1997), Remote Sensing: Principles and Interpretation, W.H.Freeman, New York.
7. Jensen, J. R., (2005), Introductory Digital Image Processing, Prentice-Hall, New Jersey
8. Joseph, G., (2004), Fundamentals of Remote Sensing, Universities Press, Hyderabad, India.

Reference book

1. Anbazhagan S., K. Subramanian, & Xiaojun Yang., (2011), Geoinformatics in Applied Geomorphology, CRC Press., ISBN: 13: 978-1439830482.
2. Anbazhagan. S, Venkatachalapathy, R. & Neelakantan, R., (2009), Exploration Geology and Geoinformatics, 1st Edition, Macmillan India Ltd., ISBN: 10:0230-63867-8.
3. Anji Reddy, M., (2008), Textbook of Remote Sensing and Geographic Information System, B.S. Publication, Hyderabad.
4. Burrough, P.A. & McDonnell, R.A., (1998), Principles of Geographic Information systems, Oxford University Press, Oxford.
5. Curran, Paul J., (1985), Principles of Remote Sensing, Longman, London & New York.
6. De Mers, & Michael N., (1999), Fundamentals of Geographic Information Systems, John Wiley & Sons, New York.
7. Drury, S. A., (2001), Image Interpretation in Geology, Blackwell, Oxford.
8. Environmental Systems Research Institute (ESRI)., (1997), Getting to know Arc View GIS, Cambridge: Geoinformation International.

9. Jensen, J.R., (2004), Remote Sensing of the Environment: An Earth Resource Perspective, Pearson Education.
10. Longley, P.A., Goodchild, M.F., Maguire, D.J. & Rhind, D.W., (2001), Geographic Information Systems and Science, Wiley, Chichester.
11. Maguire, D.J., M.F. Goodchild & D.W. Rhind., (1991), Geographic Information Systems, Longman Scientific and Technical, Harlow.
12. Sarkar, A., (2015), Practical geography: A systematic approach. Orient Black Swan Private Ltd., New Delhi.
13. Singh R. B. & Murai S., (1998), Space-informatics for Sustainable Development, Oxford and IBH Pub.
14. Singh, R.B., (1991), Environmental Monitoring: Application of Remote Sensing and GIS, Geocarto Int. Centre, Hong Kong.
15. Wolf P. R. & Dewitt B. A., (2000), Elements of Photogrammetry: With Applications in GIS, McGraw-Hill.

c. Mapping of Program Outcomes with Course Outcomes

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

SEMESTER - II				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2024	Geophysics and Exploration Geology	4	-	4

a. Course Outcome (CO)

At the end of this course, students will be able to

	Course Outcome	Level
CO1	Understand the basics of mineral exploration and drilling techniques.	Understand
CO2	Describe the reserve estimation and modelling for mineral exploration.	Apply
CO3	Explain the basics of geochemical and geophysical methods of exploration	Analyse
CO4	Analysis the geophysical data in various geological applications	Evaluate

b. Syllabus

Units	Content	Hrs.
I	Concept of mineral exploration, selection of minerals for exploration, criteria and guides for mineral search, stages of mineral exploration, various types of surveying in exploration, field equipment used in exploration geology, types of sampling - Stream sediment sampling, soil sampling, pitting, trenching, channel sampling, core sampling, grab sampling, muck sampling, and bulk sampling.	12
II	Geochemical exploration – mobility of elements, primary and secondary dispersion, geochemical anomaly, pathfinder elements and various geochemical sampling, introduction to geobotanical exploration methods,	12
III	Classification of resources and reserves; objectives and elements of resource estimation: correction factors for poor core recovery (Dilution method, Reduced- Width Method and Equal grade method), cut-off grade, stoping width, weighted average/average grade, thickness, area of influence (strike and dip), overburden thickness / ratio, bulk density or tonnage factor and assumptions (rule of gradual change and rule of nearest points). Resource estimation methods: included area method, extended area method, triangle method, polygon method, cross section method and longitudinal vertical section method; interpretation of exploration data, geological modelling for mineral exploration.	12
IV	Geophysical exploration – Gravity survey: measurement of gravity, gravity reduction / correction methods; gravity anomaly interpretation and applications, Magnetic survey: land, airborne and marine magnetic survey, Resistivity method : various electrode configurations for resistivity sounding and profiling methods, interpretation and applications of resistivity data, induced polarization method, self-potential method, seismic survey,electromagnetic survey, radiometric survey,	12
V	Objectives of drilling, types of drilling – auger drilling, cable-tool drilling, percussion drilling, diamond drilling and wire line drilling; borehole	12

	planning, borehole logging, core recovery, borehole deviation test. Geophysical well-logging, and their application of logging tools including spontaneous polarization, resistivity, litho-density, neutron, natural gamma ray.	

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Gandhi, S. M. & Sarkar, B. C., (2016), Essentials of mineral exploration and evaluation. Elsevier.
2. Haldar, S. K., (2018), Mineral exploration: principles and applications. Elsevier.
3. Reedman, J. H. (Ed.)., (2012), Techniques in mineral exploration. Springer Science & Business Media.
4. Kearey, P., Brooks, M. & Hill, I., (2002), An introduction to geophysical exploration. John Wiley & Sons.
5. Serra, O., (2003), Well Logging and Geology, Editions Technip, Paris.
6. Schlumberger Manual Log Interpretation Principles/Applications, Vol. 1 & 2, Schlumberger Education Services, New York, 1989.

Reference

1. Annels, A. E., (2012), Mineral deposit evaluation: A practical approach. Springer Science & Business Media.
2. Bagchi, T.C., Sengupta, D.K. & Rao, S.Y.L.N., (1979), Elements of Prospecting and Exploration.
3. Banerjee, P.K. & Ghosh, S., (1997), Elements of prospecting for nonfuel mineral deposits, Allied Publishers Limited.
4. Marjoribanks, R., (2010), Geological methods in mineral exploration and mining. Springer Science & Business Media.
5. Moon, C. J., Whateley, M. K. & Evans, A. M., (2006), Introduction to mineral exploration (No. Ed. 2). Blackwell publishing.
6. Wellmer, F. W., Dalheimer, M. & Wagner, M., (2007), Economic evaluations in exploration. Springer Science & Business Media.
7. Telford, W. M., Telford, W. M., Geldart, L. P. & Sheriff, R. E., (1990), Applied geophysics. Cambridge University Press.

c. Mapping of Program Outcomes with Course Outcomes

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

SEMESTER - II				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2027	Oceanography and Marine 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, biological and chemical oceanography	Understand
CO2	Describe marine geology, classification of coast and its mineral deposits	Understand
CO3	Analyze the marine environments using marine geological instruments	Apply

b. Syllabus

Units	Content	Hrs.
I	Introduction to Oceanography; Physical Oceanography: waves - definition, classification and types of waves, origin of surface waves, characteristics, growth and dissipation of wind waves, breakers and surfs; tides - definition, classification, causes and types of tide, storm surges, seiches, and tsunami; currents - definition, classification, causes and types of current, major surface current system of the world ocean; thermohaline circulation and ocean conveyor belt; Formation of bottom waters; major water masses of the world ocean.	9
II	Atmospheric circulation, global wind pattern: global distribution of atmospheric mass, Zonal and Meridional winds. Indian Monsoon (Southwest and Northeast monsoon), inter tropical convergence zone (ITCZ); Ekman spiral, Ekman transport and upwelling; El Nino and Indian Ocean Dipole.	9
III	Introduction to Chemical and Biological Oceanography; physical and chemical properties of seawater; oceanic profile and depth features; biological productivity in the ocean; factors affecting primary productivity; measurements of ocean productivity; .	9
IV	Marine Geology: oceanic sediments and microfossils: formation processes, marine stratigraphy, correlation and chronology; turbidity current, submarine and sedimentation processes . classification of marine mineral deposits: origin and depositional system of marine resources. beach placers: shelf deposits, deep ocean phosphatic, polymetallic nodules, sulphate deposits, hydrocarbon deposits; marine pollution: pathways, resilience time, pollutants in the marine environment. Introduction to marine geological instruments. concept of sea-level changes and processes.	9
V	Paleoceanography: Approaches to paleoceanographic reconstructions, various proxy indicators for paleoceanographic interpretation; reconstruction of past monsoon and ocean productivity changes by using marine proxy	9

	records; Gateway hypothesis: opening and closing of ocean gateways and their effect on ocean circulation	

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Lal D.S., (2013), Climatology and Oceanography, Sharda Pustak Bhavan Publishers and Distributors.
2. Singh, Savindra., (2014), Oceanography, Pravalika Publications.
3. Siddhartha, K., (2016), Oceanography A Brief Introduction, Kisalaya Publications Pvt. Limited.
4. Singh, S., (2020), Oceanography Pravalika Publication, Allahabad.

Reference Book

1. Turekian, K. K. & Holland, H. D., (2013), Treatise on geochemistry: Volume 8 The Oceans and Marine Geochemistry, Elsevier Science Ltd.
2. King. C., (1966), An Introduction to Oceanography. McGraw Hill Book Co, New York.
3. Pickard G.L. & Emery, W.J., (1982), Descriptive Physical Oceanography. Pergamon Press, Oxford.
4. Pickard, G.L., (1963), Description of Physical Oceanography. Pergamon Press, London.
5. Weisberg, J. & Parish, H., (1974), Introduction to Oceanography. McGraw-Hill Kogakusha, Ltd., Tokyo.
6. Yasso, W.E., (1965), Oceanography. Holt, Rinehert and Winston, Inc., 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**
GLY2025	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	Understand the genesis of various igneous rocks through study of their mineralogy and texture in both hand specimen and under the microscope	Skill
CO2	Understand and explain the characteristics of metamorphic rocks for their identification and some understanding on analytical tools.	Skill

b. Syllabus

Units	**Content**	**Hrs.**
I	Megascopic identification of felsic, intermediate, mafic and ultramafic rocks (both volcanic and plutonic equivalents), ultrapotassic rocks, pyroclastic rocks, alkaline and associated rocks and their Indian occurrences.	12
II	Microscopic (textural and mineralogical) identification of felsic, intermediate, mafic and ultramafic rocks (both volcanic and plutonic equivalents), ultrapotassic rocks, pyroclastic rocks, alkaline and associated rocks. Study of common igneous textures with special focus to genetic significance.	12
III	CIPW Norm calculations using the Whole-rock analysis data of igneous rocks, Plotting of common igneous rocks in the IUGS Classification diagrams.	12
IV	Identification of Minerals, reactants and products in Hand specimen and thin sections: metapelites, metabasic and calcareous rocks; Deciphering deformational and metamorphic history in thin sections;	12
V	Mineral analyses and projections (Practical/homework); Hands on analytical techniques SEM, EPMA, XRF and XRD etc	12

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Laboratory reports
- ✔ Assignments
- ✔ Viva

Text Book

1. Winter, J. D., (2014), Principles of igneous and metamorphic petrology (Vol. 2). Harlow, UK: Pearson education.
2. Yardley, B.W.D., (1990), Atlas of Metamorphic Rocks and Their Textures, Prentice Hall.

Reference

1. Bard, J. P., (1986), Microtextures of igneous and metamorphic rocks. Springer Science & Business Media.
2. Bucher, K. & Grapes, R., (2011), Petrogenesis of Metamorphic Rocks. Springer-Verlag Berlin Heidelberg.
3. MacKenzie, W. S., Donaldson, C. H. & Guilford, C., (1982), Atlas of igneous rocks and their textures (Vol. 148). Harlow: Longman.
4. Philpotts, A. R., (1989), Petrography of igneous and metamorphic rocks. Pearson College Division.
5. 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 - II				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2026	Remote Sensing and GIS **(Practical)**	-	2	2

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Interpretation of different Aerial and Satellite data basic information for various applications, and analysis	Apply
CO2	Interpretation and image processing technique of Satellite Data	Skill

b. Syllabus

Units	**Content**	**Hrs.**
I	Stereo vision Test and Anatomy of Pocket & Mirror Stereoscopes, Interpretation of Aerial Photographs (Stereo vision), Decoding of Different Satellite data, Interpretation of Satellite Photographs.	12
II	Conducting the UAV and data acquisition, mosaic and image interpretation using PIX4D, Image processing and GIS software.	12
III	Linear Stretching, Spatial filter, Edge enhancement, Image Processing of - Image Classification supervised and unsupervised, Image interpretation and applications.	12
IV	Scanning/Data input and Geo referencing of map, Digitization, Data Editing, Labeling and geo database creation (Vector data generation – Point, line, Polygon), Projection and Transformation of map	12
V	Creation of non-spatial/attribute data base, Linking of Spatial and Non Spatial data, Query based Retrieval and Spatial display of non- spatial data, Data editing/ error removal for GIS analysis – Regrouping, Dissolving / Merging, Map design and Map Layout creation. Prepare a report consisting of five exercises on using any RS and GIS Software on above-mentioned themes.	12

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Laboratory reports
- ✔ Assignments
- ✔ Viva

Text Book

1. Jensen, J. R., (2005), Introductory Digital Image Processing, Prentice-Hall, New Jersey.
2. Lillesand, T. M., Kiefer, R. W. & Chipman, J. W., (2008), Remote Sensing and Image Interpretation, John Wiley & Sons, New Delhi.
3. Sabins, Floyd F. Jr., (1997), Remote Sensing: Principles and Interpretation, W.H.Freeman, New York.

References

1. Burrough, P.A. & McDonnell, R.A., (1998), Principles of Geographic Information systems, Oxford University Press, Oxford.
2. Drury, S. A., (2001), Image Interpretation in Geology, Blackwell, Oxford.

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**
GLYVA01	Introduction to Atmospheric Science	2	-	2

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understand the fundamental of atmosphere and their conditions	Understand
CO2	Study of atmospheric changes with relation to time and region	Analyse

b. Syllabus

Units	Content	Hrs.
I	Atmospheric cycle, classification of atmosphere, thermal structure of the atmosphere and its composition. radiation: basic laws - Rayleigh and Mie scattering, multiple scattering, radiation from the sun, solar constant, effect of clouds, surface and planetary albedo.	6
II	Clausius- clapeyron equation, adiabatic process of moist air; thermodynamic diagrams. vertical stability of the atmosphere: dry and moist air parcel and slice methods. tropical convection. atmospheric optics - visibility - optical phenomenon - rainbows, haloes, corona, glarg, mirage.	6
III	Fair weather electric field in the atmosphere and potential gradients, ionization in the atmosphere. electrical fields in thunderstorms, theories of thunderstorm electrification - structure of lightening flash-mechanism of earth-atmospheric change balance-role of thunderstorms.	6
IV	Cloud classification, condensation nuclei, growth of cloud drops and ice-crystals, precipitation mechanisms: Bergeron, Findeisen process, coalescence process – precipitation of warm and mixed clouds, artificial precipitation, hail suppression, fog and cloud.	6
V	General weather systems of India - monsoon system, El-Nino Southern Oscillation (ENSO), cyclone and jet stream, western disturbances and severe local convective systems, distribution of precipitation over India.	6

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Ahrens, C. D., (2014), Essentials of meteorology: an invitation to the atmosphere. Cengage Learning.
2. Chandrasekar A., (2022), Basics of Atmospheric Science, PHI Learning Private Limited, Delhi, Second Edition.

3. Hess S. L., (1979), Introduction to Theoretical Meteorology, Krieger Publishing Company Malabar, Florida.

Reference Book

1. Houghton H. G., (1985), Physical Meteorology, MIT Press.
2. Neil, C., (2011), The Atmosphere and Ocean: A Physical Introduction (Advancing Weather and Climate Science), Wiley-Blackwell.
3. Roland B. Stull., (2011), Meteorology (for scientists and engineers), Brooks/Cole Thomson Learning.

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**
GLYVA02	Introduction to Climate Science	2	-	2

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Describe and understanding of the climate, their classifications	Understand
CO2	Study the climatic changes and its impacts	Analyse

b. Syllabus

Units	**Content**	**Hrs.**
I	Climatology composition and structure of atmosphere; observed zonally symmetric circulations, meridional circulation models, mean meridional and eddy transport of momentum and energy, angular momentum and energy budgets; insolation, heat budget of earth, temperature, pressure and winds,	6
II	Atmospheric circulation (air-masses, fronts and upper air circulation, cyclones and anticyclones (tropical and temperate), climatic classification of Koppen & Thornthwaite, ENSO Events (El Nino, La Nina and Southern Oscillations).	6
III	Meteorological hazards and disasters (cyclones, thunderstorms, tornadoes, hailstorms, heat and cold waves drought and cloudburst , glacial lake outburst (GLOF), Climate Change: Evidences and Causes of Climatic Change in the past, Human impact on Global Climate.	6
IV	Climatic time scales earth's radiation balance latitudinal and seasonal variation of insolation concept of atmospheric temperature, pressure, wind belts atmospheric moisture, stability and instability cloud formation and precipitation, water balance.	6
V	Properties of air masses, Air mass identification and analysis, Air mass source regions and classification Climates dominated by air masses Fronts and frontogenesis Extra tropical cyclones Classification of climates: Koppen's and Thornthwaite's scheme of classification.	6

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Lal D.S., (2013), Climatology and Oceanography, Sharda Pustak Bhavan Publishers and Distributors.
2. Critchfield H. J., (2008), General Climatology, PHI Learning Pvt. Ltd , Fourth Edition.

3. Moran J. M., (2010), Climate studies-Introduction to climate science, American Meteorological Society.

Reference Book

1. Sellers W. D., (1960), Physical climatology, University of Chicago, First Edition.
2. Hartmann D. L., (2015), Global Physical Climatology, Academic Press Inc, Second Edition.
3. E. Aguado & J. E. Burt., (2007), Understanding Weathering and Climate, Pearson Prentice Hall.
4. C. Neil., (2011), The Atmosphere and Ocean: A Physical Introduction (Advancing Weather and Climate Science), Wiley.

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**
GLYVA03	Introduction to Planetary Science	2	-	2

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Understanding of fundamental of solar system.	Understand
CO2	Study the processes of origin and evaluations of solar system	Analyse

b. Syllabus

Units	**Content**	**Hrs.**
I	Introduction to the interdisciplinary field of planetary science, which can be defined as the scientific study of planets, moons, and planetary systems	6
II	Origin and development of the Solar System with an emphasis on what is presently known about the Solar System and its constituents, with particular emphasis on the terrestrial (or rocky)	6
III	Introduced to the major processes that shape the interior and surface of rocky planets and moons, as well as the processes that affect the atmospheres of the terrestrial planets and the giant planets of the outer Solar System	6
IV	Composition and mineralogy – rocky, icy, gaseous composition of planets – Mercury, Venus, Earth, and Mars – and the Earth's moon	6
V	Morphology and processes – impact cratering, volcanism, tectonism in planets such as Mercury, Venus, Earth, and Mars – and the Earth's moon	6

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. De Pater, I. & Lissauer, J. J., (2015), Planetary sciences. Cambridge University Press.
2. Tielens, A. G., (2005), The physics and chemistry of the interstellar medium. Cambridge University Press.

Reference Book

1. Seager, S. (Ed.)., (2011), Exoplanets. University of Arizona Press.
2. Heng, K., (2017), Exoplanetary atmospheres: theoretical concepts and foundations.

3. Ishak, B., (2019), Introduction to astrochemistry: chemical evolution from interstellar clouds to star and planet formation: by Yamamoto S., Japan, Springer, 2018. ISBN: 9784431541707.

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**
GLYVA04	Hyperspectral Remote Sensing	-	2	2

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Classification techniques in hyperspectral data	Apply
CO2	Application of hyperspectral, thermal and microwave data	Analyse

b. Syllabus

Units	**Content**	**Hrs.**
I	Introduction to hyperspectral remote sensing, atmospheric windows and hyperspectral bands - interaction with rocks, soil, water and other natural and built-up environments.	6
II	Atmospheric correction of hyperspectral data, pre-processing of hyperspectral data, MNF, PPI, n-dimensional visualizer and end members collection	6
III	Classification of Hyperspectral images: Spectral Angle Mapper - Spectral feature fitting- various rocks and minerals.	6
IV	Spectro radiometric measurements of soil, water, plants/leave stock in hyperspectral ranges, interpretation of thermal imagery for geological mapping.	6
V	Interpretation of Earth Resources Satellite, hyperspectral satellite images, interpretation of day and night thermal imagery- for various geological studies.	6

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Laboratory reports
- ✔ Assignments
- ✔ Viva

Text Book

1. Estes., J.E., (1983), Manual of Remote Sensing (2nd Edition), American Society of Photogrammetry.
2. Curran, P., (1985), Principles of Remote Sensing, Longman, London.
3. Lillisand, T.M. & Kiefer, P.W., (1986), Remote Sensing and Image interpretation, John Wiley&Sons, New York.
4. Lintz, J. and Simonett L.S. (Eds.)., 1976, Remote Sensing of Environment, Addition-Wesley, Readings, Mass.
5. Lo. C.P., (1986), Applied Remote Sensing, Longman, London.

6. Sabins, F.F. Jr., (1978), Remote Sensing Principles and interpretation, Freeman, San Francisco.
7. Burney, S.S., (1988), Application of Thermal Imaging, Adam Hilger Publications.

References

1. Lillisand, T.M. & Kiefer, P.W., (1986), Remote Sensing and Image interpretation, John Wiley & Sons, New York.
2. Michel, H.R., (1986), Remote Sensing Methods and Application, John Wiley & Sons.
3. Voliak, K. I. & Bunkin, A., (2001), Laser remote sensing of the ocean: methods and applications. John Wiley & Sons, New York.

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**
GLY4021	Internship / Industrial Training		2	2

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	In-depth learning during industrial attachment	Analyse
CO2	Industrial attachment helps in their growth and development preparation for professional work	Evaluate

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 and Viva		

c. Mapping of Program Outcomes with Course Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	✔	✔	✔	✔	✔	✔
CO2	✔	✔	✔	✔	✔	✔

Semester-III

SEMESTER - III				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2031	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 origin of life and its evolution through geological time	Understand
CO2	Describe morphology, classification, evolutionary trends and taphonomy record with Indian examples of various vertebrate, invertebrate fossils and siliceous, calcareous and phosphatic micro- and nano-fossils.	Analyze
CO3	Application of microfossils in hydrocarbon exploration, reconstruction of paleoecology, paleoenvironments and paleogeography and intercontinental correlation	Apply

b. Syllabus

Units	Content	Hrs.
I	Modern systematics, concept and kind of type specimens, species, speciation and adaptive radiation. Ichnofossils - modes of preservation, classifications and ichnofacies. Classification, evolution and modes of life of major invertebrate groups: Mollusca (Bivalvia, Gastropoda and Cephalopoda), Brachiopoda, Echinodermata, Trilobita; Evolution and biological affinity of Graptolite.	9
II	Approaches to palaeoecological and palaeoenvironmental studies based on benthic communities, trace fossils and taphonomic record with Indian examples. Distribution, migration and dispersal of organisms applied to palaeobiogeography and plate-tectonics with Indian examples. Evolution of man, elephant and horse and their fossils localities in India; Devonian flora, Gondwana flora, and Deccan Intertrappean flora.	9
III	Objectives and scope of Micropaleontology; Modern field and laboratory techniques in the study of microfossils: sampling methodology (collection of microfossils from surface and sub-surface), and processing techniques, scanning electron microscopy and mass spectrometry); Environmental parameters controlling the distribution of micro-organisms.	9
IV	Types of Microfossils. Calcareous Microfossils: Foraminifera - Planktic foraminifera, benthic foraminifera. Calcareous nannofossils - Ostracoda - Pteropods; Siliceous Microfossils: Radiolaria, diatoms and silicoflagellate.	9
V	Biostratigraphic and palaeoenvironmental significance. Application of Micropaleontology in hydrocarbon exploration.	9
Tasks and Assignments:		

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text book

1. Clarksons, E.N.K., (1998), Invertebrate Paleontology and Evolution, Allen and Unwin, London.
2. Haq B. U. & 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.

Reference book

1. Bignot, G., (1985), Elements of Micropaleontology, London.
2. Boardman, R.S., Cheethan, A.M. & Rowell, A.J., (1988), Fossil Invertebrates, Blackwell.
3. Haslett, S. K., (2002), Quaternary Environmental Micropaleontology, Oxford.
4. Horowitz, A.S. & Potter, E.D., (1971), Introductory Petrography of Fossils, Springer Verlag. Mayr, E., (1971), Population, Species and Evolution, Harvard.
5. Houghton, J., (1997), Global Warming, Cambridge Univ. Press.
6. Jones, T.P. & Rowe, T.P., (1999), Fossil plants and spores, Modern Techniques, Geological Soc. of London.
7. Pinet, R., (1992), Oceanography: An introduction to the Planet Oceanus, West Pub,Co
8. Saraswati, P. K. & Srinivasan M. S., (2016), Micropaleontology: Principles and Applications, Springer.
9. Smith, A.B., (1994), Systematics and Fossil Record – Documenting Evolutionary Patterns, Blackwell.
10. Strean, C.W. & Carroll, R.L., (1989), Paleontology – the record of life, John Wiley & Sons.
11. Tolmazin, D., (1985), Elements of Dyanamic Oceanography, Allen and Unwin.

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**
GLY2032	Sedimentology	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 process of formation of siliciclastic and carbonate sediments and sedimentary rocks, their texture and structures, and reconstruction of paleo-environments.	Understand
CO2	Explain different sedimentary environments and identify their processes and products.	Apply
CO3	Elaborate the relationship between tectonics and sedimentary basin formation and knowledge of sequence stratigraphy.	Analyze

b. Syllabus

Units	**Content**	**Hrs.**
I	Introduction to sedimentary processes: origin, transport and deposition of sediments, sediment classification; Fundamental of fluid flow: Laminar vs turbulent flow, Reynolds number, Froude Number; particle transport by fluids and sediment gravity flows.	9
II	Sedimentary texture, textural parameter and significance; Concept of flow regimes and bedforms; Sedimentary structures; Paleocurrent analysis. Terrigenous clastic and chemically precipitated rocks and their classification;	9
III	Siliciclastic rocks: composition, classification, genesis and occurrences of sandstone, shale and conglomerate; lithification and diagenesis; Non-siliciclastic: composition, texture, genesis and diagenesis of limestone and dolomite; genesis and diagenesis of chert, phosphorites, iron-rich sediments and evaporate.	9
IV	General idea about depositional environments; fluvial, deltaic, estuarine, tidal-flat and deep sea environments; Sequence Stratigraphy: Concept of sequence stratigraphy; Walther's law; Aggradation, progradation, retrogradation, transgression, regression, onlap, offlap, overlap, toplap; Sequence boundaries.	9
V	System tracts: low stand system tract, high stand system tract, transgressive system tract; Parasequences and sedimentary cycle; Maximum flooding surfaces, marine flooding surface; Sea-level in geological history. Basin analysis, tectonics, and sedimentation; Application of isotopes in reconstruction of Paleoenvironments.	9

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Boggs, S., (1995), Principles of Sedimentology and Stratigraphy. Print ice Hall, New Jersey.
2. Nichols, G., (1999), Sedimentology and Stratigraphy. Wiley-Blackwell.
3. Pettijohn, F.J., (1975), Sedimentary Rocks. Harper and Row Publm, New Delhi.
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.

Reference Book

1. Allen, P.A., (1997), Earth Surface Processes. Blackwell.
2. Collinson, J.D. & Thompson, D.B., (1988), Sedimentary Structures. Unwin-Hyman, London.
3. Hsu, K.J., (2004), Physics of Sedimentology. Springer Verlag, Berlin.
4. Leeder, M., (2009), Sedimentology and Sedimentary Basins: from Turbulence to Tectonics. John Wiley & Sons.
5. Leeder, M.R., (1982), Sedimentology: Process and Product (344p). George Alien &Unwin, London.
6. Lindholm, R.C., (1987), A Practical Approach to Sedimentology. Allcn ane Unwin, London.
7. Miall, A.D., (1999), Principles of Sedimentary Basin Analysis (3rd Ed.). Springer Verlag, New York.
8. Reading, H.G., (2009), Sedimentary Environments: Processes, Facies and Stratigraphy. John Wiley & Sons.
9. Reineck, H.E. & Singh I.B., (1980), Depositional Sedimentary Environments: With Reference to Terrigenous Clastics. Springer.

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**
GLY2033	Stratigraphy	3	-	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Evaluate the principals of advanced stratigraphy and details of geological time scale	Evaluate
CO2	Understand and identify the Indian stratigraphic systems	Understand
CO3	Analyze the age and boundary problems of various ages	Analyze

b. Syllabus

Units	**Content**	**Hrs.**
I	Principles of Stratigraphy: Litho-stratigraphy, Biostratigraphy, chrono-stratigraphy, Magneto-stratigraphy and their Applications, Stratigraphic Correlation; Stratotypes and its importance; A new Geologic Time Scale. Paleogeography and important events in Precambrian time; Archaean successions and economic importance of Peninsular India: Dharwar Supergroup, Banded Gneiss complex, Sargur Group, Bundelkhand Group, Singhbhum-Orissa region (Iron ore Group, Singhbhum Group and Proterozoic succession).	9
II	Proterozoic successions and economic importance of Vindhyan Supergroup, Aravalli Supergroup, Delhi Supergroup, Cuddapah Supergroup, Sausar Group, and Lesser Himalayan sedimentary belts; Precambrian-Cambrian boundary. Palaeogeography and important events of the Palaeozoic Era; Palaeozoic stratigraphy of the Himalaya with reference to Palaeozoic succession in Spiti valley, Himachal Pradesh and Kashmir and Gondwana Supergroup.	9
III	Mesozoic time and important events: Triassic and Jurassic systems, Marine Triassic sequences of the Himalaya with special reference to Spiti Valley, Triassic succession in Kumaun Himalaya; Permian-Triassic boundary; Gondwana Supergroup: Distribution, stratigraphic classification, and economic importance.	9
IV	Geological Succession and economic importance of Jurassic of Western India; Cretaceous successions of Cauvery basin, South India and Narmada valley; Cretaceous-Tertiary boundary; Deccan Traps: Spatio-temporal distribution of volcano-sedimentary sequences, Infra/inter-trappeans beds, Age of Deccan traps, Economic importance; Stratigraphy of Siwalik Group.	9

V	Palaeogene and Neogene global events and successions in India; Neogene-Quaternary boundary. Boundary problems in Indian stratigraphy: Precambrian/Cambrian); Permian/Triassic; Cretaceous/Tertiary; Neogene/Quaternary; Global events of Jurassic and Cretaceous periods.	9

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

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 Book

1. Chetty, T.R.K., (2017), Proterozoic Orogens of India: A Critical Window to Gondwana, Elsevier.
2. Doyle, P. & Bennett, M.R., (1996), Unlocking the Stratigraphic Record. John Wiley & Sons.
3. Naqvi, S.M., (2005), Geology and Evolution of the Indian Plate: From Hadean to Holocene-4 Ga to 4 Ka. Capital Pub., New Delhi.
4. Pascoe, E.H., (1968), A Manual of the Geology of India & Burma (Vols.IN). Govt. of India Press, Delhi.
5. Pomerol, C., (1982), The Cenozoic Era? Tertiary and Quaternary. Ellis Harwood Ltd., Halsted Press.
6. Schoch, R.M., (1989), Stratigraphy: Principles and Methods. Van Nostrand Reinhold, 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**
GLY2034	Hydrogeology and Sustainable Development	3	-	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Basic concepts of the origin and occurrences, distribution, and types of groundwater	Understand
CO2	Evaluate the properties-Darcy law, Pumping test and characteristics of groundwater	Evaluate
CO3	Study of groundwater basins, recharge, and management studies	Apply

b. Syllabus

Units	**Content**	**Hrs.**
I	Groundwater and genetic types - Meteoric, Juvenile and Connate. Groundwater Distribution (subsurface): Zone of Aeration, Capillary fringe, Zone of Saturation and Water Table- Hydrological Properties of Rocks: Porosity, Permeability, Specific Yield and Specific Retention, Base Flow, Transmissivity and Storage Coefficient - Hydraulic Conductivity – Aquifers: Types - unconfined, confined, leaky and perched aquifers: Darcy's Law: Validity of Darcy's Law - Groundwater Flow Equations: Steady, Unsteady and Radial Flow	9
II	Groundwater: Run off, estimation of runoff, reach, Horton overflow, flood and modeling, Different types of water bodies: Lake, river, bond and their linkages, Problems due to over-exploitation of groundwater, hard rock aquifer system.	9
III	Outline of methods of groundwater exploration - Drilling Methods for Groundwater Bore Wells, Tube wells - Groundwater Budget and estimations: Volume estimation, and budget, Groundwater Management – Watershed: definition, watershed management: Climate change in water resource.	9
IV	Physical and Chemical Parameters of Groundwater Quality - Analysis of Major and Minor Elements in groundwater - Outline of Water Quality Standards and Guidelines: WHO, BIS and ICAR - Water Quality Parameters for Drinking, Agriculture, and Industrial Uses - Graphical Representation and Interpretation of Water Quality Data: WILCOX, USSL, GIBBS plot, Piper Trilinear diagrams; Coastal Aquifers: Ghyben-Herzberg relation and Saline Water Intrusion.	9

V	Sustainable Development: Rainwater harvesting definition, methods, and design of harvesting structures - Groundwater recharge: natural and artificial methods, Artificial recharge techniques - Groundwater recharge and impacts: Environment, and benefit to the society. Groundwater provinces of India and Tamil Nadu. Application of Geospatial technology in groundwater exploration, Groundwater modeling.	9

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Fetter, C. W., (2007), Applied Hydrology, CBS Publications.
2. Karanth, K. R., (1998), Hydrogeology, Tata McGraw-Hill Publishing Company.
3. Karanath, K.R., (1987), Groundwater Assessment, Development & Management, Tata Mc Graw Hill.
4. Raghunath, H.M., (2003), Groundwater, New age international publications.
5. Ragunath, H.M., (2007), Groundwater, New Age International Publishers, Delhi.
6. Todd D. K. & Mays, L. W., (2013), Groundwater Hydrology, Wiley son's publication.

Reference Book

1. Anbazhagan, S., Jothibasu, A. & Balamurugan, G., (2019), Climate Change in Water Resources. Allied Publishers, New Delhi, India.
2. Bouwer, H., (2014), Groundwater Hydrology, McGraw hill education private limited.
3. Deman, MCJ. Smith G.S. & Verstappen, H. T., (1986), Remote Sensing for resources development and environmental management, A. A. Ballkema Publishers, Totterdam, Netherlands.
4. Gurugnanam, B., (2009), Essentials of Hydrogeology, NIPA publications, New Delhi.
5. Ramakrishnan. S., (1998), Groundwater, CBS Publishers & Distributors.

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**
GLY2035	Fuel 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; origin, occurrence, and classification of coal.	Understand
CO2	Prospecting of Coal and Gas explain about chemical characterization	Understand
CO3	Fundamentals of coal geological problems and purpose of fuel analysis	Analyze

b. Syllabus

Units	Content	Hrs.
I	Introduction to fuel geology and its economic strength. Petroleum- Physical and chemical properties; transformation of organic matter into kerogen; origin, nature, generation and migration of oil and gas; surface and subsurface occurrence of petroleum and gas. Characteristics of reservoir rocks and traps and seals (structural, stratigraphic and correlation).	9
II	Prospecting for oil and gas, drilling, and logging procedures; Oil and gas fields of India; geology of the productive oil and gas fields of India; reservoir characteristics, relationship between porosity, permeability and texture, Correlation of well log parameters with seismic properties.	9
III	Fundamentals of coal Geology: Origin of coal; macroscopic ingredients and microscopic constituents; the concept of maceral and microliths types. sedimentology of coal bearing strata; rank, grade, and type of coal; Chemical characterization: proximate and ultimate analysis.	9
IV	Classification of Coal: Indian and International classifications of coal; coal petrology and its application in solving industrial and geological problems; preparation of coal for industrial purposes; coal carbonization (coke manufacture) coal gasification and coal hydrogenation, Coal bed – methane: a new energy resource. Shale gas. Indian coal deposits.	9
V	Atomic fuel- Mode of occurrence and methods of prospecting and productive geological horizons in India; nuclear power stations of the country and future prospects; Importance of Fuels in Modem Economy. Impact of atomic Energy over conventional fuels. Conservation of non-renewable & associated Renewable resources.	9

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Chandra, D., Singh, R.M. & Singh, M.P., (2000), Textbook of Coal (Indian context), Tara Book Agency, Kamachha, Varanasi.
2. Hunt, J. M., (1995), Petroleum Geochemistry and Geology, W.H.Freeman & Co Ltd.
3. Selley, R.C., (1997), Elements of Petroleum Geology, Academic Press.
4. Singh, M.P., (1998), Coal and Organic Petrology. Hindustan Publishing Corporation.

Reference Book

1. Ahmed, T., (2001), Researvour Engineering. Gulf Professional Publishing.
2. Levorsen A.I., (1985), Geology of Petroleum, CBS Publishers and Distributors, Delhi,
3. Thomas, L., (2012), Coal geology, Wiley India Pvt. Ltd.
4. Tissot, B. P. & Welte, D. H., (1984), Petroleum formation and occurrence. Springer-Verlag Berlin Heidelberg.

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**
GLY2036	Sedimentology and 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	Identify, classify and describe clastic and non-clastic sedimentary rocks and sedimentary structures and reconstruction of paleoenvironment.	Apply
CO2	Identification of important mega and micro-fossils and interpretation of their paleoenvironmental conditions for deposition	Analyse

b. Syllabus

Units	**Content**	**Hrs.**
I	Megascopy of Clastic and Non-clastic Rocks; Identification of sedimentary structures and their Palaeo environmental significance.	12
II	Microscopic Examination of Important Sedimentary Rocks; Grain-size Analysis: Plotting of size-distribution data as Frequency and Cumulative.	12
III	Curves; Computation of Statistical Parameters and Interpretation; Identification of sedimentary structures and their Palaeo environmental significance; Palaeocurrent Analysis; Classification of sedimentary rocks by plotting the modal and whole-rock chemical compositions in relevant triangular diagrams; Study and interpretation of isopach and facies maps.	12
IV	Study of the morphological characters of some important invertebrate fossils belonging to Brachiopoda, Bivalvia, Gastropoda, Ammonoidea, Trilobita, Echinoidea and corals;	12
V	Techniques of separation of microfossils from the matrix; Types of microfossils - calcareous, siliceous, phosphatic and organic-walled microfossils.	12

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Laboratory reports
- ✔ Assignments
- ✔ Viva

Text Book

1. Murray, J. W., (1985), Atlas of invertebrate macrofossils. Wiley.
2. Reineck, H.E. & Singh, I.B., (1973), Depositional Sedimentary Environments. Springer-Verlag.

3. Tucker, M.E., (1981), Sedimentary Petrology: An Introduction, Wiley & Sons, New York.
4. Tucker, M.E., (1990), Carbonate Sedimentology, Blackwell Scientific Publication.

References

1. Bignot, G., (1985), Elements of Micropaleontoogy, London.
2. Collins, J.D. & Thompson, D.B., (1982), Sedimentary Structures. George Allen & Unwin, London.
3. Greensmith, J. T., (1984), Petrology of Sedimentary rocks, Thomas Murby Publ.
4. Jones, T.P. & Rowe, T.P., (1999), Fossil plants and spores, Modern Techniques, Geological Soc. of London.
5. Lindholm, R.C., (1987), A Practical Approach to Sedimentology. Allen & Unwin, London.
6. Miall, A.D., (2000), Principles of Basin Analysis, Springer-Verlag.

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**
GLY2037	Hydrogeology and Fuel 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	Analyze the rainfall, groundwater, geophysical data using different map and software	Apply
CO2	Understand the concept of hydrocarbon deposits and data interpretation	Analyse

b. Syllabus

Units	**Content**	**Hrs.**
I	Demonstrate the rainfall and its assessment for hydrogeological studies. Analyse the water sample for major element studies. Rainfall - Arithmetic mean method Assessment - rainfall - Thiesson polygon method Assessment. Rainfall – Isohyetal method Assessment. Major elements Analysis for water. Graphical interpretation of water quality data. Water Quality - Irrigation use Assessment.	12
II	Explain the water level data assessment. Analyze the problems related to porosity and specific yield and retention. Preparation of water level map and its interpretation Problems - Porosity Specific and Specific yield / retention. Pumping test data interpretation. Isohyetal map generation through surfer software.	12
III	Execute the resistivity study in the field and assess the interpretation. Resistivity survey and the interpretation for lithology and water resources - Wenner method Resistivity survey and the interpretation for lithology and water resources - Schlumberger method Rock works software applications in Hydrogeology Surfer software and its application in Hydrogeology	12
IV	Exercise based on various source rock, reservoir, and trap. Case study of petroliferous basins on India; Indo-Gangetic, Bombay high, Cauvery Basin, Krishna-Godavari basin, and Assam oil field	12
V	Study of hand specimens of different ranks of coals such as peat, lignite, sub-bituminous, bituminous, and anthracite. Physical and chemical classification. Proximate and ultimate analysis of coal.	12

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Laboratory reports
- ✔ Assignments
- ✔ Viva

Text Book

1. Chandra, D., Singh, R.M. & Singh, M.P., (2000), Textbook of Coal (Indian context), Tara Book Agency, Kamachha, Varanasi.
2. Hunt, J. M., (1995), Petroleum Geochemistry and Geology, W.H.Freeman & Co Ltd.
3. Todd D. K. & Mays, L. W., (2013), Groundwater Hydrology, Wiley son's publication.

Reference Book

1. Ramakrishnan. S., (1998), Groundwater, CBS Publishers & Distributors.

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	Geostatistics and Computer Applications **(Skill Enhancement Course)**	2	-	2

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Describe the principles of computer, statistical analysis using the computer programming.	Understand
CO2	Use the Geological software and explain the application of this software in geology.	Apply

b. Syllabus

Units	**Content**	**Hrs.**
I	Statistical methods; mean; median and mode; standard deviation; skewness and kurtosis and their interrelationship; scatter diagrams; frequency distribution; histogram; correlation, covariance, correlation coefficient and regression.	6
II	Geostatistics: Meaning, Definition, and History of Geostatistics, Spatial data-Definition and Characteristic Types: Point, Line, Polygon, Data interpolation and extrapolation with different methods.	6
III	Exploratory spatial data analysis: ESDA/EDA - Meaning of Exploratory spatial data analysis (ESDA) and Exploratory data analysis (EDA). Concepts of data distribution in space - Data – i. Sampling, ii. Heterogeneity, iii. Dependency, Univariate description.	6
IV	Distribution of sample variance and chi square distribution; probability; testing normal distribution; students 't' test, paired t test, pooled t test, regression coefficient of t test, 'f' test; confidence interval, analysis; calculation of variance- covariance, simple linear models; cluster analysis.	6
V	Statistical analysis using various statistical software including Excel, Origin, Stereonet and Surfer. Geo statistical analysis with case study – Frequency ratio, AHP. Geospatial visualization of geodataset.	6

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Davis, J. C., (2002), Statistics and data analysis in geology, third edition, John Wiley & Sons, Singapore.
2. Hohn, M.E., (1988), Geostatistics and Petroleum Geology, New York: Van Nostrand Reinhold,
3. Merriam D.F., (2000), Computer Methods in the Geosciences, Elsevier.
4. Sharma, D. D., (2009), Geostatistics with applications in Earth sciences jointly published with Capital Publishing Company.

Reference Book

1. Chapman, S.J., (2008), Fortran for Scientists and Engineers (3rd Edn.) McGraw-Hill.
2. Cressie, N.A.C., (1993), Statistics for Spatial Data, New York: John Wiley & Sons, Inc.
3. Duetsch, C.V. & Journel, A.G., (1992), GSLIB: Geostatistical Software Library and User's Guide, New York: Oxford University Press,
4. Isaaks, E. H. & Srivastava, R.M., (1989), An Introduction to Applied Geostatistics, Oxford University Press,
5. Kitanidis P.K., (1997), Introduction to Geostatistics, Applications in Hydrogeology, Cambridge University Press.
6. Sancheti. D. C. & Kapoor, V. K., (1992), Statistics Theory, Methods and Application. Sultan Chand & Sons publishers.
7. Simon W., (2000), Houlding Geostatistics: Modeling and Spatial Analysis, Springer: Har/CdrEdition (8 June 2000).
8. Tomislav, Hengl., (2009), A Practical Guide to Geostatistical Mapping. ISBN 978-90-9024981-0.

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**
GLYEC04	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 methods of mining processes, sampling methods and examination	Understand
CO2	Explain the methods of underground mining	Apply
CO3	Analyze Mining profits and excavation of Resources	Analyze

b. Syllabus

Units	Content	Hrs.
I	Alluvial, open- pit and underground mining methods; drifting; cross-cutting; winzing; stoping; room and pillaring; top-slicing; sub-level caving and block caving; ocean bottom mining.	9
II	Guides to ore localization. Factors in evaluating a mineral deposit; mine examination; theory and methods of sampling; sampling calculations; recoverable values. Intersecting loci and ring targets.	9
III	Mine hazards; subsidence and the support of mine excavation; timber treatment; methods of breaking rocks; drilling blast holes; explosives used in mining; blasting practices.	9
IV	Mine organization and operation; shaft sinking; mine drainage; ventilation; illumination. Cost of mining; future costs and profits; life of mine; present value of mine and its determination by compound interest and Hoskold formula methods.	9
V	Amortisation; calculations pertaining to valuation of mines of uniform and non-uniform annual income. Sale of mineral products; metal prices and mine valuation; valuation of prospects: developed mines and working mines; valuation report.	9

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Book

1. Arogyaswamy R. N. P., (2017), Courses in Mining Geology, Oxford & IBH publishing.
2. Young, G.J., (1946), Elements of Mining, McGraw-Hill.

Reference Book

1. Abzalov, M., (2016), Applied Mining Geology, Springer International Publishing.
2. Pivnyak, G., Bondarenko, V., Kovalevs'ka, I. & Illiashov, M., (2013), Mining of Mineral Deposits, CRC Press.

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**
GLYEC05	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 rock failure mechanism, rock mass classifications and the concept of rock slope engineering	Apply
CO3	Study the soil classification and importance of soil behavior for foundation engineering	Analyse

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

Text Book

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 Book

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 - III				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLYEC06	Medical Geology and Society	3	0	3

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understand the role of geologic environment including impacts of trace elements on human health, flora and fauna	Understand
CO2	Study the potential health benefits of geologic materials and geologic processes	Apply
CO3	Familiar with modern analytical techniques for determining the chemistry of various geogenic materials	Analyse

b. Syllabus

Units	Content	Hrs.
I	Introduction to medical geology: historical aspects and scope of medical geology, definition of medical geology, current status and future prospects of medical geology basic principles of toxicology, dosage, deficiency, exposure, pathways, toxic elements, radioactive elements	9
II	Medical geochemistry: distribution and abundance of elements, geochemical mapping for medical geology, sampling methods for geogenic contaminants-methods for characterization of various geogenic contaminants.	9
III	Medical geology and human health: geophagy, arsenic in drinking water, fluoride in drinking water, nitrate contamination, selenium deficiency, water hardness, iodine deficiency disorders, health effects of cadmium, health effects of geogenic dust and volcanic gases, coal geochemistry and health, mine drainage, radioactivity and human health, geological effects on animal and plant health	9
IV	Scope of medical geology in India, Indian case studies of arsenic contamination in groundwater, high fluoride content, iodine deficiency, selenium toxicity and high nitrate content in the groundwater. factors make India vulnerable to geochemical health hazards, challenges in medical geology	9
V	Minerals and society: socio economic factors and their role in human health, applications of minerals, lithium pharmacotherapy, balneotherapy, therapeutic applications of clay, milk of magnesia, plaster of paris and alkaline water	9

Tasks and Assignments:

Each student is required to undergo the following:

✔ Class discussions

- ✔ Assignments
- ✔ Seminars
- ✔ Tests

Text Books

1. Alloway, B., Centeno, J. A., Finkelman, R. B., Fuge, R., Lindh, U. & Smedley, P., (2013), Essentials of medical geology: revised edition (Vol. 805). O. Selinus (Ed.). Springer Netherlands.
2. Censi, P., Darrah, T. H. & Erel, Y., (2013), Medical geochemistry. Geological materials and health.
3. Dissanayake, C. B. & Chandrajith, R., (2009), Introduction to medical geology. Springer science & business media.
4. Ibaraki, M. & Mori, H. (Eds.)., (2017), Progress in medical geology. Cambridge Scholars Publishing.
5. Komatina, M., (2004), Medical geology: effects of geological environments on human health. Elsevier.

Reference

1. Randive, K., Pingle, S. & Agnihotri, A. (Eds.)., (2022), Medical Geology in Mining: Health Hazards Due to Metal Toxicity. Springer.
2. Selinus, O., Finkelman, R. B. & Centeno, J. A. (Eds.)., (2010), Medical Geology: a regional synthesis. Springer Science & Business Media.
3. Skinner, H. C. W. & Berger, A. R. (Eds.)., (2003), Geology and health: closing the gap. Oxford University Press.

c. Mapping of Program Outcomes with Course Outcomes

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

SEMESTER - IV

SEMESTER - IV				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2041	Dissertation			12

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Gaining 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.	Analyse
CO2	Students must develop and evaluate the theoretical and empirical positioning of the selected topic.	Evaluate
CO3	The ability to research 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 Masters' 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 research activity itself. There are many ways to disseminate research results, and the production of a research dissertation is one of them.	14

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 Masters' thesis in CUTN be between 5,000 to 20,000 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 - IV				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2042	Geological Field Study		3	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Handling the different geological field equipment and mapping	Skill
CO2	Identification of minerals, rocks and fossils and interpretation of their genesis.	Apply

b. Syllabus

Units	**Content**	**Hrs.**
I	Reading of Topomap (Toposheet), Open Series Map (OSM), National Map Policy (NMP) 2005, Coordinate Sytem - latitude & longitude, Projection system, Global zoning and Toposheet numbering, toposheetin index reading, contour interpreting, location identification – triangulation method, drainage pattern recognition and interpretation, geomorphological features identification from toposheet, and land use and land cover mapping. Introduction - Literatures and maps - Description of rocks - Physiography - Topographic expressions and relief - Inliers and outliers - requirements of the field - suggestions and precautions.	30
II	Field Study – Topographic maps: Base Maps, Scale of maps – Depiction of relief - Latitudes and Longitudes- Map grids - Measurement of mapped areas- Mounting and folding field maps- Marking on maps. Field documentation: Field sketches and Drawings - Field photographs. Basic field procedures: Location - Soils and vegetation- measuring distances - Compass and tape traversing - Determination of slopes and gradients- Measuring difference in elevation - Field identification of rocks - Basic field observations.	30
III	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. 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.	30
IV	Field Study – Survey, contact zone and lithological mapping, area estimation, different lithological unit identification, exposing to various geological field	40

	including Archean, Paleozoic, Mesozoic, Cenozoic formations including mapping and rock or fossil sample collection,	
V	Reports and presentation – Report consist of the Unit-I to Unit-IV and they must prepare and present it neatly. Moreover, both should contain the information like geology, stratigraphy, toposheet number, field photograph and samples.	30

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Field reports
- ✔ Assignments
- ✔ Viva

Text Book

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.

References

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	✔	✔	✔	✔	✔	✔

SEMESTER – IV				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLY2043	Research Methodology	3	-	3

d. 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

e. Syllabus

Units	**Content**	**Hrs.**
I	Meaning, Concept, nature steps types and characteristics of research, scientific inquiry, Philosophical and Sociological foundations of research, Interdisciplinary approach and its implications in various research areas.	9
II	Qualitative and quantitative methods of research, field and laboratory experimental studies, Characteristics of methods and their implications in the research area.	9
III	Importance and need for Research Ethics and Scientific Research, Research proposal and its elements, Formulation of Hypothesis, Identification of Problem, Development of objectives and characteristics of objectives, Literature Survey, Reference collection, Use of Libraries and Information Retrieval systems, Internet Browsing – assessing the current status.	9
IV	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. Redesigning, research tools-like questionnaire, opinion ire, observation, interviews, scales and tests etc. Analysis of qualitative data based on various tools. Analysis of quantitative data and its presentation with tables, graphs etc. Statistical tools and techniques of data analysis measures of central tendency, dispersion. Decision making with hypothesis testing through parametric and non-parametric tests. Validity and delimitations of research findings.	9
V	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.	9

	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). Effective Illustration – Tables, Charts and Figures. Reference style. Presenting Scientific Papers-Synopsis writing –Multimedia techniques in paper presentation.	

Tasks and Assignments:

Each student is required to undergo the following:

✔ Assignments/ Seminars / Class Tests

Text Book

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., (2021), Earth Science New Methods and Studies (Eds) Apple Academic Press. ISBN 9781774631874.

Reference Book

1. Tiberius, C., van der Marel, H., Reudink, R. & van Leijen, F., (2022), Surveying and Mapping. TU Delft OPEN Publishing.
2. Panneerselvam, R., (2014), Research methodology. PHI Learning Pvt. Ltd.
3. Lohr, S. L., (2021), Sampling: design and analysis. Chapman and Hall/CRC.

f. Mapping of Program Outcomes with Course Outcomes

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

MOOC Courses (NPTEL)

SEMESTER – IV				
Course Code	**Course Name**	**L**	**P**	**Credits**
GLYON01	Remote Sensing for Natural Hazard Studies	3	-	3
GLYON02	Earthquake Geology: A Tool for Seismic Hazard Assessment			
GLYON03	Environmental Science			
GLYON04	Climate Change - Extreme Events			
GLYON05	Disaster Risks Reduction and Management			
GLYON05	Climate Risk, Adaptation, and Sustainable Development			

Open Elective

SEMESTER - II				
Course Code	**Course Name**	L	P	**Credits**
GLYOE01	Earth, Ocean and Climate 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 basic concepts of geology	Understand
CO2	Understand the basic concepts of oceanography and climatology	Understand
CO3	Study various Geological application and techniques	Apply

b. Syllabus

Units	**Content**	**Hrs.**
I	**Geology I (Origin of the Earth)** Origin of the Solar system: Various hypothesis related to the origin of solar system; Age of the Earth. Ancient Earth: Supercontinents; Pangaea; Gondwana. Plate tectonics: Breakup of the supercontinents; movement of the Indian subcontinent and formation of the Himalayas.	9
II	**Geology II (Earth's processes)**: Geological Time Scale: Precambrian, Palaeozoic, Mesozoic and Cenozoic time and geological events throughout the history of the Earth. Types of Rocks: Igneous; metamorphic and sedimentary rocks; Formation of rocks. Economic resources associated with rocks: minerals; Essential; critical and strategic. Origin and Major Stages of Life Evolution on Earth; Fossil records and their applications.	9
III	**Oceanography**: Overview of the Oceans: Introduction to the oceanography; Physical Properties of seawater. Marine Provinces: the pelagic; the benthic; the neritic province. Layers of the Ocean: Mixed layer; Thermocline; deep ocean. Ocean Circulation: Thermohaline circulation; surface currents; deep currents; upwelling; El Niño and La Niña (ENSO). Waves and tides: origin of waves; types of waves, forces behind tides; spring and neap tides. Ocean primary Productivity: Phytoplankton blooms; ocean's most productive areas.	9
IV	**Climate Science:** General idea about climate and weather, Climate classification: Global; regional and local climates, Climate of India. Global wind pattern: Walker circulations; Hadley cell; Ferrel cell; Polar cell. Monsoon: Mechanism of monsoon. Climate change: Meaning of climate change; factors behind climate change. Climate of the past: climate fluctuations throughout the Earth's history; evidences of climate change; how to investigate climate of the past.	9

V	**Applications of Geology:** Exploration Geosciences: Hydrocarbon and ground water and mineral exploration. Remote sensing applications in the Disaster management: Earthquake mapping; flood plains. Geology applications in building dams, tunnels	9

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

- ✔ Assignments
- ✔ Seminars
- ✔ Class Tests

Text Books:

1. Trujillo, A. P., Thurman, H. V., (2005), Essentials of Oceanography. UK: Pearson Prentice Hall.
2. D. S. Lal., (2002), Oceanography. India: Sharada Pustak Mahal.
3. D. S. Lal., (2003), Climatology Publisher, Sharda Pustak Bhawan.
4. The Encyclopedia of Climatology., (1987), Egypt: Springer US.
5. Mahapatra, G. B., (2008), A Text Book of Geology. Delhi: CBS Publishers and Distributers.
6. Schmittner, A., Fisher, D., Houston, L., Moore, K. D. & Capalbo, S., (2018), Introduction to Climate Science, an online textbook. In AGU Fall Meeting Abstracts (Vol. 2018, pp. ED51I-0739).

Reference Books

1. Bucher, K. & Frey, M., (1994), Petrogenesis of Metamorphic Rocks, Springer Verlag.
2. King. C., (1966), An Introduction to Oceanography. McGraw Hill Book Co, New York.
3. Miyashiro, A., (1994), Metamorphic Petrology, Oxford University Press.
4. Pickard G.L. & Emery, W.J., (1982), Descriptive Physical Oceanography. Pergamon Press, Oxford.
5. Ragland, P. C., (1989), Basic analytical Petrology. Oxford University Press.

g. 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**
GLYOE02	Earth System 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 origin of Earth, its position in universe and various Earth processes that modify the Earth surface.	Understand
CO2	Understand the evolution of Geological structures, their importance to the society and explain the natural hazards	Understand
CO3	Identify the common rock-forming minerals and different rock types.	Understand

b. Syllabus

Units	Content	Hrs.
I	Introduction to Earth System Science, Solar System, Earth's History and its place in the universe, Earth's Material, Earth's Endogenic and Exogenic Processes; Weathering and Erosion; Orogeny and Epeirogeny; Types of Deformation; Types and development of Geological Structures: Importance to Society	9
II	Geomorphological Landforms and its importance: fluvial, eolian, glacial, volcanic and coastal; Geomorphology of India: Peninsular, Extra Peninsular, Indo-Gangetic Plain; Relationship between climate and geomorphic landforms.	9
III	Plate Tectonics: Continental Drift, Plates and boundaries, Plate Tectonics Model-Paleomagnetism, Sea Floor Spreading, Polar Wandering and Reversal of Earth's Magnetic Field; Mechanism of plate tectonics and its societal importance; Earthquakes and associated Hazards-Landslides, Tsunami, and volcanism.	9
IV	Definition of mineral; common rock forming minerals and their properties; Distribution and use of common metallic, non-metallic, and precious minerals.	9
V	Types of Igneous rocks; origin of igneous rocks; identification of different igneous textures, intrusive and extrusive structures associated with the igneous rocks; Types of metamorphism; textures, classification of sediments, and classification of different types of sedimentary rocks.	9

Tasks and Assignments:

Each student is required to undergo the following:

- ✔ Assignments
- ✔ Seminars

✔ Class Tests

References

1. Anthony R. P. & Ague, J. J., (2009), Principles of Igneous and Metamorphic Petrology. Cambridge.
2. Bangar, K. M., (2005), Principles of engineering geology, Standard Publishers Distributors.
3. Carlson, D. & Plummer, C. C., (2008), Physical Geology, McGraw- Hill.
4. Duff, P. M. D. & Duff, D. (Eds.)., (1993), Holmes' principles of physical geology, Taylor & Francis.
5. Davies, G.F., (1999), Dynamic Earth: Plates, Plumes and Mantle Convection. Cambridge University Press.
6. Fossen, H., (2010), Structural Geology, Cambridge University Press.
7. Perkins, D., (2010), Mineralogy, Pearson.

h. Mapping of Program Outcomes with Course Outcomes

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