UNIVERSITY OF JAMMU

(NAAC ACCREDITED 'A ++' GRADE' UNIVERSITY)
Baba Sahib Ambedkar Road, Jammu-180006 (J&K)

Academic Section
Email: academicsectionju14@gmail.com

NOTIFICATION
(25/Dec./Adp./128)

It is hereby notified for the information of all concerned that the Vice-Chancellor, in anticipation of the approval of the Academic Council, is pleased to authorize the adoption of the syllabi and courses of studies for **Post Graduate Programme** in **Geology** under **NEP-2020** as per details given below:-

Two Year Post Graduate Programme under NEP-2020

Subject	Semester	For the examinations to be held in the year
Geology	Semester-I	December 2025, 2026 and 2027
	Semester-II	May 2026, 2027 and 2028
	Semester-III	December 2026, 2027 and 2028
	Semester-IV	May 2027, 2028 and 2029

One Year Post Graduate Programme under NEP-2020

Subject	Semester	For the examinations to be held in the year
Geology	Semester-I	December 2026, 2027 and 2028
	Semester-II	May 2027, 2028 and 2029

The Syllabi of the courses are also available on the University website: www.jammuuniversity.ac.in

Sd/-
DEAN ACADEMIC AFFAIRS

No. F. Acd/II/25/ 12921-935
Dated: 18/12/2025
Copy for information and necessary action to:

1. Dean, Faculty of Science
2. Convener, Board of Studies in Geology
3. Director, CITES&M, University of Jammu for directing the concerned to upload the notification on University Website
4. All members of the Board of Studies
5. Joint Registrar (Evaluation/P.G. Exam.)
6. Programmer, Computer Section, Examination Wing

18/12/25
Joint Registrar (Academic)

16/12 16/12/25

DEPARTMENT OF GEOLOGY, UNIVERSITY OF JAMMU

Course Framework of Two Years Postgraduate Programme in Applied Geology under National Education Policy (NEP) 2020

Post Graduate Syllabi 2025															
S. No.	Course No.	Course Title	No. of Credits	Credits Level	Credits Points	Course Type	Marks		Nature of course				SWAYAM / MOOC	Vocational Course	Research Project/ Summer Internship/ Dissertation
						Core / Elective/ any other	Theory	Practical	Global	National	Regional	Skill			
Semester-I															
1	P2AGTC101	Applied Stratigraphy	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
2	P2AGTC102	Structural Geology and Geotectonics	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
3	P2AGTC103	Igneous Petrology and Geochemistry	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
4	P2AGTC104	Applied Hydrogeology	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
5	P2AGTC105	Applied Mineralogy	2	6.5	13	Core	50	-	✓	✓	✓	-	-	-	-
6	P2AGPC106	Practical (101,102,103,104,105)	4	6.5	26	Core	-	100	✓	✓	✓	-	-	-	-
7	P2AGPC107	Weekend Geological Field Work (5-7 days)	2	6.5	13	Core	50		-	-	✓	✓	-	-	✓
Semester-II															
8	P2AGTC201	Sedimentology: Processes & Petrology	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
9	P2AGTC202	Applied Palaeontology	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
10	P2AGTC203	Geospatial Techniques	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
11	P2AGTC204	Metamorphic Petrology	2	6.5	13	Core	50	-	✓	✓	✓	-	-	-	-
12	P2AGTC205	Geo-exploration & Mining Geology	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
13	P2AGTC206	Earth Surface Features & Processes	2	6.5	13	Core	50	-	✓	✓	✓	-	-	-	-
14	P2AGPC207	Practical (201, 202, 203, 204, 205)	4	6.5	26	Core	-	100	✓	✓	✓	-	-	-	-
15	P2AGVC251	Field and or Laboratory Work in Geology	4	6.5	26	Vocational	100						-	✓	✓

Semester-III															
16	P2AGTC301	Applied Micropalaeontology and Oceanography	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
17	P2AGTC302	Ore Geology	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
18	P2AGTC303	Sedimentary Basin Analysis & Hydrocarbon Resources	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
19	P2AGTC304	Geotechnical Engineering	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
20	P2AGTC305	Application of Remote Sensing and GIS in Geology	2	6.5	13	Core	50	-	✓	✓	✓	-	-	-	-
21	P2AGPC306	Practical (301, 302, 303, 304, 305)	4	6.5	26	Core	-	100	✓	✓	✓	-	-	-	-
22	P2AGPC307	Geological Field Work (Outstation 10-15 days)	2	6.5	13	Core	50		✓	✓	✓	✓	-	-	✓
23	P2AGMO351	MOOC/SWAYAM Course	4	6.5	26	Core	100	-	✓	✓	✓	-	✓	-	-
Semester-IV															
24	P2AGTC401	Quaternary Geology and Palaeoclimate	4	6.5	26	Core	100	-	✓	✓	✓	-	-	-	-
25	P2AGTC402	Natural Hazard & Disaster Management	2	6.5	13	Core	50	-	✓	✓	✓	-	-	-	-
26	P2AGTE403	Gemology	2	6.5	13	Elective	50	-	✓	✓	✓	-	-	-	-
27	P2AGTE404	Glaciology	2	6.5	13	Elective	50	-	✓	✓	✓	-	-	-	-
28	P2AGTE405	Earthquake Geology	2	6.5	13	Elective	50	-	✓	✓	✓	-	-	-	-
29	P2AGRC406	Dissertation	16	6.5	104	Core	400		✓	✓	✓	✓	-	-	✓

SYLLABUS FOR 2 YEAR PG PROGRAM IN APPLIED GEOLOGY

UNIVERSITY OF JAMMU

Syllabus and Courses of Study for

M.Sc. Applied Geology

PGFSG003

as per NEP 2020

(2025)

DEPARTMENT OF GEOLOGY, UNIVERSITY OF JAMMU
Course Framework of Two Years Postgraduate Programme in Applied Geology under National Education Policy (NEP) 2020

Course Code	Course Title		Credit	Marks	Total Credits
Semester I (for sessions December 2025, 2026, 2027)					
P2AGTC101	Applied Stratigraphy		4	100	24
P2AGTC102	Structural Geology and Geotectonics		4	100	
P2AGTC103	Igneous Petrology & Geochemistry		4	100	
P2AGTC104	Applied Hydrogeology		4	100	
P2AGTC105	Applied Mineralogy		2	50	
P2AGPC106	Practical (101, 102, 103, 104, 105)		4	100	
P2AGPC107	Weekend Geological Field Work (5-7 days)		2	50	
Semester II (for sessions May 2026, 2027, 2028)					
P2AGTC201	Sedimentology: Processes & Petrology		4	100	24
P2AGTC202	Applied Palaeontology		4	100	
P2AGTC203	Geospatial Techniques		4	100	
P2AGTC204	Metamorphic Petrology		2	50	
P2AGTC205	Geo-exploration & Mining Geology		4	100	
P2AGTC206	Earth Surface Features & Processes		2	50	
P2AGPC207	Practical (201, 202, 203, 204, 205)		4	100	
P2AGVC251	Field and/or Laboratory work in Geology		4	100	Mandatory for students who intend to exit after 1 Year*
*Student existing after successfully completing 1 year with Vocational Course will be awarded **PG Diploma in Geology**					
Semester III (for sessions December 2026, 2027, 2028)					
P2AGTC301	Applied Micropalaeontology and Oceanography		4	100	24
P2AGTC302	Ore Geology		4	100	
P2AGTC303	Sedimentary Basin Analysis & Hydrocarbon Resources		4	100	
P2AGTC304	Geotechnical Engineering		4	100	
P2AGTC305	Application of Remote Sensing & GIS in Geology		2	50	
P2AGPC306	Practical (301, 302, 303, 304,305)		4	100	
P2AGPC307	Geological Field Work (Outstation 10-15 days)		2	50	
P2AGMO351	MOOC/SWAYAM Course		4	100	4
Semester IV (for sessions May 2027, 2028, 2029)					
P2AGTC401	Quaternary Geology and Palaeoclimate		4	100	24
P2AGTC402	Natural Hazards& Disaster Management		2	50	
P2AGTE403	Gemology	*Select any one*	2	50	
P2AGTE404	Glaciology		2	50	
P2AGTE405	Earthquake Geology		2	50	
P2AGRC406	Dissertation		16	400	
Total credits to be earned by the student					**100 (96+4)**

Scheme of Examination

A) Scheme of Examination: (For 2 credits course having Four Units)

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as:

MCQ on LMS + Subjective Test	Syllabus to be cover In the examination	Time allotted for the examination	Weightage (Marks)
Test I (after 30 days)	25%	1 hour	5+5
Test II (after 60 days)	26 to 50%	1 hour	5+5
Theory	Syllabus to be covere in the examination	Time allotted for the examination	Weightage (Marks)
Major test (after 90 days)	100%	2 ½ hours	30
Total			50

Test I and Test II

The subjective Test of Test I and Test II would consist of three short answer type questions. Students are required to answer two questions (5 Marks). No preparatory holidays shall be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 7 out of 20 will be eligible to re-appear in the Test I and/ or Test II only once.

Major Test

The Major test will comprise of two sections, Section–A and Section–B. Section-A will have one compulsory question comprising of 10 parts (minimum 02 from each unit) of 01 mark each. Section-B will have 04 questions of 10 marks each to be set from the last two units (02 from each unit). Students are required to attempt 01 question from each unit of section B. In major test there should not be gap of more than one day in between two tests.

B) Scheme of Examination: (for 04 credit course having Five Units)

The students shall be continuously evaluated during the conduct of each course on the basis of his/ her performance as:

MCQ on LMS+ Subjective Test	Syllabus to be covered In the examination	Time allotted for the examination	% Weightage (Marks)
Test I (after 30 days)	20%	1 hour	10+10
Test II(after 60 days)	21 to 40%	1 hour	10+10
Theory	Syllabus to be covered in examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. No preparatory holidays shall be provided for the Test I and Test II. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section–A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section-B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). Students are required to attempt 01 question from each unit of section B. In major test there should not be a gap of more than two days in between two tests.

C) Practical 04 Credits

	Time allotted for examination	%Weightage (Marks)		
Midterm appraisal	4 hours	25%		
External examination	4 hours	75%	50%	Exam
			25%	Viva-Voce
Total				100

External Practical Research (thesis/ project/ dissertation) Examination

External Practical / Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one / two Senior Professors of concerned department, concerned teacher and outside expert to be appointed by the Vice Chancellor out of the panel to be provided by the Head of the department who shall evaluate / assess final practical performance / dissertation of the students.

Note: For evaluation of thesis / project / dissertation concerned Board of Studies (BoS) has the flexibility to change the pattern of evaluation.

Programme and course out comes as per NEP2020

Curricula developed and implemented have relevance to the local, national, regional and global developmental needs, which is reflected in the Programme outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes (COs) of the Programmes offered by the University:

The department of geology offers two Programme including M.Sc. Applied Geology & Ph.D. The curriculum developed at master degree level in M.Sc. Applied Geology have great relevance in the present day scenario as the courses offered by department imparting the knowledge about deciphering the earth's history, processes operating in their formation to arm the students with the knowledge of ancient events and environments, the knowledge of stratigraphic methods, concept of the distribution of Precambrian Shield belts and their evolution, knowledge about Paleozoic, Mesozoic and Cenozoic strata with faunal and floral elements and the Gondwana successions, fundamental knowledge about the structures in different settings ranging from regional, macroscopic to microscopic scale, define and discuss the fundamental concepts and different data sets, and the methods of structural geology and structural analysis, Students will learn to interpret the structures to unfurl the history of deformation in the rocks including advanced ideas of internal structure of earth. Introduction of the latest concept of geomagnetism and its application. The knowledge on tectonic evolution of Himalaya and Indian craton. concept of geomagnetism and its application, imparting the basic knowledge about the rock forming minerals, their formation, complexity, associations, identification and allied technical contexts, Imparting the basic knowledge about the rock forming minerals, their formation, complexity, associations, identification and allied technical contexts, basic idea of mineral interaction with light, and its utility for their understanding involving their 'optical properties, depositional mechanism of different sedimentary basins in relation to tectonics. Sequence stratigraphy and its application, fundamental concepts governing the landforms; understand the concept of various geomorphologic processes and landform evolution. Introduce the latest concept of chronology based on geomorphologic studies in tectonic zones. Remote Sensing Technology has emerged as an important tool for scientifically managing resources and environment, the technology enhanced our capability of resources exploration, mapping and monitoring on local and global scale, the courses has been designed with the objectives to acquaint the students with basic principles of remote sensing, GIS and GPS.To impart the knowledge about the concept of geochemistry and classification of elements. To provide working knowledge of various microfossil groups and their geological significance, the modern concepts, dynamics and resources of the marine realm, the course contrives to introduce the history of the fuel geology with a futuristic vision, also bearing in mind the importance of present energy challenges of which coal, oil and gas form an important and inseparable part. Stress will be on inculcating the classical ideas and imparting the latest knowledge – their origin, distribution, exploration, exploitation and production. Students should see this opportunity to explore energy options in India that are intricately based on the conditions created by geology. The courses impart the knowledge and understanding about ores, the various processes of the ore formations and modern concepts of the ore genesis. Students understand the formation, mode of occurrences and types of various petrological ore associations. The introductory course in engineering geology provides the understanding of how earth materials and geologic processes influence various civil engineering works. It also describes various important classifications, methods of investigation in various civil engineering projects with an emphasis on making construction decisions. On the other hand, the study of environment geology helps to impart knowledge about pollution and their remedial measures in order to mitigate the environmental problems. To acquaint the students with the concept of earth formation, minerals, rocks, processes of landforms, fossils, volcanoes, plate tectonics, groundwater, etc.

Detailed Syllabus

SEMESTER - I

Course Code:P2AGTC101 **Title: Applied Stratigraphy**
Credits: 4 **Maximum Marks:100**
Duration of Examination: 3 hours **(Minor I-20, Minor II 20, Major 60)**

(Syllabus for the examination to be held in Dec. 2025, Dec. 2026 & Dec. 2027)

CourseObjectives: To impart working knowledge of stratigraphic principle and methods, stratigraphic boundaries, stratigraphic facies analysis and depositional environment, basic concept, types of stratigraphic units and their application in geology; distribution of Precambrian, Paleozoic, Mesozoic, Cainozoic and Quaternary rock successions, fauna and flora of India.

Course Outcomes: After completion of course the students will be able to

- Identified the stratigraphic outcrops in the field at regional and global level
- Interpreted the depositional environment and geologic setting of the area
- Analyzed paleocurrent direction, calculated the age, correlated the rock strata, mark the position of strata and sequences, etc.

Unit 1: Stratigraphic Principles and Codes of Nomenclature

1.1. Stratigraphy definition and Procedures; Procedures for establishing and revising stratigraphic units; Naming of Stratigraphic Units; Publications; codes of stratigraphic nomenclature

1.2. Principles of Stratigraphy: Walther's law, order of superposition; Principle of Uniformitarian's; Principle of faunal succession; principle of catastrophic event; principle of homotaxis, contemporaneous; Synchronous beds; lithology; principle of original horizontality; principle of cross-cutting; inclusion, incomplete records; base level; accommodation; preservational potential and cyclicity.

1.3. Stratigraphic Correlation: Lithostratigraphy Correlation - continuity of contacts between units; lithologic similarity; Stratigraphic position of a unit in sequence of strata; well logs; Structural characteristics; Biostratigraphy Correlation-Stages of evolution of fauna; Guide fossil; Fauna resemblances; position in biostratigraphic sequence; Chronostratigraphy correlation- Quantitative chronology; eustatic changes in sea level;

1.4. Stratigraphic Classification: lithostratigraphy; biostratigraphy; chronostratigraphy; Geological time scale and earth's climate History,

Unit 2: Stratigraphy Events/boundaries

2.1. Precambrian - Cambrian boundary: Identification in India and global level, age, biota extinction and causes.

2.2. Permo-Triassic boundary: Identification in India and global level, age, biota extinction and causes.

2.3. Cretaceous-Tertiary boundary: identification in India and global level, age, biota extinction and causes.

2.4. Neogene-Quaternary boundary: identification in India and global level, age, biotic extinction and causes.

Unit 3: Stratigraphy Types and Applications

3.1. Sequence Stratigraphy and Radiometric Stratigraphy: concept and applications.

3.2. Magnetostratigraphy, Ichnostratigraphy and Chemostratigraphy: concept and applications.

3.3. Facies Stratigraphy, Isotopic Stratigraphy and Cyclostratigraphy: concept and applications.

3.4. Archaeology Stratigraphy and Extraterrestrial Stratigraphy: concept and applications.

Unit4: Precambrian Stratigraphy

4.1. Precambrian major belts of peninsular India

4.2 Archean stratigraphy of Peninsular India (Karnataka and Madhya Pradesh group; Rajasthan)

4.3 Proterozoic Stratigraphy of Peninsular India (Cuddapah and Vindhyan group)

4.4 Extra Peninsular India (lesser Himalaya - Chandpur, Mandhali, Nagthat, Jaunsar, Blaini, Infra-Krol, Krol and Shali and higher Himalaya-Vaikrita, Haimanta, Salkhala, Dogra Slate, Jutogh, Chail, Shimla Slate and Darjeeling Formations)

Unit 5. Palaeozoic, Mesozoic and Cenozoic Stratigraphy

5.1 Palaeozoic stratigraphy: Distribution and Correlation of Palaeozoic of Peninsular and extra peninsular India and their tectonic history during Paleozoic times.

5.2 Mesozoic Stratigraphy: Distribution, Classification, depositional characteristics, fauna, and flora of Triassic of Spiti, Jurassic of Kutch and Cretaceous of Trichnapolly systems of India; Mesozoic Transgression and Regressions. Field characters and age of Deccan traps, concept of Gondwanaland and global distribution of Gondwana rocks

5.3. Palaeogene Stratigraphy: Distribution, Classification, depositionalcharacteristics, fauna, and flora of the Palaeogene, Himalayan Ophiolite mélanges and their significance.

5.4 Neogene Stratigraphy: Distribution, Classification, depositional characteristics, fauna and flora of the Siwalik and Karewas Deposits. Quaternary Stratigraphy: Distribution of the Quaternary sediments in India

Books Recommended

1. Weller, J. Marvin. 1959. Stratigraphic Principles and Practice. Harper and Brothers Publishers; New York.
2. Dubbar, C Owen & Rodger, John. 1957. Principles of Stratigraphy. New York, Wiley.
3. Hedberg, Hollis D. 1976. International Stratigraphic Guide.
4. Michael A. Murphy & Amos Salvador. 1999. International Stratigraphic Guide - An abridged version. Episodes.
5. Code of Stratigraphic Nomenclature, 1971. GSI Publications.
6. Krishnan, M.S. 1943.Geology of India and Burma.CBS Publisher and Distributer Pvt. Limited.
7. Pasco, E.H. 1965.Manual of Geology of India & Burma, Vol. I-III. Manager of Publications
8. Wadia, D.N. 1919.Geology of India. TATA McGraw-Hills
9. Ravindra Kumar.1985. Fundamentals of Historical Geology & Stratigraphy of India. Wiley Eastern Limited.
10. Naqvi, S. M. & Rogers, J. J. W. 1987.Precambrian Geology of India. Oxford University Press.
11. Pichamuthu, C.S. 1985. Archean Geology. Cambridge University Press.
12. Rama Krishna, M. &Vadhyanathan, R. 2008. Stratigraphy Vol I - II (2008). Geological Society of India.
13. Shah, S. K. 2018. Historical Geology. Scientific Publishers.
14. John W. Harbauch& Danil F. Merriam. 1968. Computer Application in Stratigraphic Analysis. Wiley.
15. Octavian Catuneanu. 2022. Principles of Sequence Stratigraphy. Elsevier
16. Jaitely A.K., Singh, A.D., Pandey, B. & Nath, S. 2011.Palaeontology and Stratigraphy: Basics to Applications. Muddrak, Varanasi.
17. Odin, G.S. 1982. Numerical Dating in Stratigraphy. John Wiley & sons
18. Michel E. Brookfield.2016. Principles of Stratigraphy. Wiley Blackwell Publisher
19. Robert E. Sheriff. 1980. Seismic Stratigraphy. IHRDC Publisher, Boston.
20. Robert L. Brenner &Trimonthy R. Mc Hargue. 1988. Prentice Hall.
21. Key Papers on the major boundaries (1988) by Radhakrishnan & Ramakrishna, Shah, Sahni & Ranga Rao.
22. Miall A.D. 1965. The Geology of Stratigraphic Sequence. Springer.
23. Sahu. B.K. 2023. Stratigraphy and palaeontology. Wisdom Press.
24. Gary Nichols (2012. Sedimentology and Stratigraphy. Willy-Blackwell.

Course No.: P2AGTC102
Credits: 04
Duration of Examination: 3 hours

Title: Structural Geology and Geotectonics
Maximum Marks: 100
(Minor I-20, Minor II 20, Major 60)

(Syllabus for the examination to be held in Dec. 2025, Dec. 2026 & Dec. 2027)

Course Objectives: To develop a comprehensive understanding of rock deformation processes and the structural fats of Earth's crust.

Course Outcomes: At the completion of this course the students shall be able to

- Understand the tectonic settings through rock mechanics, micro and macro structural features
- Learn various techniques for plotting structural data in geological maps

UNIT I - Fundamentals of Structural Geology

1.1. Concept of Stress and Strain, Stress in homogeneous and inhomogeneous rocks.
1.2. Basics of Rheology and Mechanisms of Rock deformation
1.3. Techniques of Strain measurement, common types of finite strain ellipsoids.
1.4. Mohr diagram, and Wellman diagram.

UNIT II Structures formed in extensional, compressional, brittle and plastic regimes

2.1 Mechanism of folding and internal strain accommodation, Geometry of folds and their classification schemes (Dip isogons and superimposed folding).
2.2. Mechanism of faulting, geometry and analysis of fractures, joints and faults.
2.3 Types of Faults: Normal Fault, Reverse fault, Strike-slip fault.
2.4 Geometry and analyses of brittle-ductile and ductile shear zones.

UNIT III Interior of Earth and Plate Movements

3.1. Seismic investigations of Earth's interior, wave's velocity, velocity curves, density distribution, elastic properties, pressure and temperature within the earth.

3.2. Plate Margins: seismicity, structure and plate motions in constructive, destructive and conservative plate margins.
3.3. Concept of continental drift, Evidences of sea floor spreading, causes of plate motion, oceanic ridges, trenches, and benioff zone.
3.4. Composition of the earth's crust and upper mantle and crust-mantle relationship.

UNIT IV Microstructures and Tectonic Significance

4.1. Kinematics and Palaeostress analysis.
4.2. Time relationship between deformation and recrystallization.
4.3. Rock Fabric: Planar and Linear fabrics, terminology, development and significance.
4.4. Common types of finite strain ellipsoids, L-tectonics, S-tectonic and L-S tectonics.

UNIT-V Himalayan Tectonics

5.1. Himalayan Tectonics: sedimentation, closing of continents, shifting of depositional basins.
5.2. Subduction tectonics: Drift and subduction of the Indian Plate, Andaman subduction zone and Makran subduction.
5.3. Himalayan orogeny and tectonic models: critical taper wedge model, rolling hinge model.
5.4. Tectonics of fold thrust belt, and foreland basin (fault propagated folds, fault bend folds).

Books Recommended

1. Badgley, P.C. — Structure and Tectonics
2. Ramsay, J.G. — Folding and fracturing of Rocks
3. Hobbs, B., Means W. & William, P. — An Outline of Structural Geology iv.
4. Gosh, S.K. Structural Geology: — Fundamentals & Modern Developments
5. Dennis, J.G. Structural Geology: — An Introduction
6. Park, R. G. — Foundations of Structural Geology
7. Davis, G H — Structural Geology of Rocks & Regions
8. Jain, A K — Structural Geology, 2014
9. Passchier&Trouw — Microtectonics
10. Twiss & Moore — Structural Geology
11. Ramsay, J.G. and Martin, I. — Techniques in Structural Geology, vol. I, II
12. Condie, K C — Plate Tectonics and Crustal Evolution
13. Cox, A — Plate Tectonics and Geomagnetic Reversals
14. Balanssov — Basic problems in Geotectonics
15. Wadia, D N — Geology of India
16. Gansser, A — Geology of the Himalaya
17. Valdiya, K S — Aspects of Geotectonics
18. Fossen Haakon — Structural Geology
19. Mitra and Marshak — Structural Geology and Tectonics
20. Rowland — Structural Analysis and Synthesis
21. Valdiya, K S — The Making of India

Course No.: P2AGTC103 | **Title: Igneous Petrology and Geochemistry**
Credits: 04 | **Maximum Marks: 100**
Duration of Examination: 3 hours | **(Minor I-20, Minor II 20, Major 60)**

(Syllabus for the examination to be held in Dec. 2025, Dec. 2026 & Dec. 2027)

Course Objectives: The Course aims to make to the students well-versed with the strength of Igneous Petrology Theory applications.

Course Outcomes:

- The students will develop skills, to identifying a wide range of igneous rocks
- The students will understand the processes of formation of the rocks.
- The students will learn to identify the corresponding geological settings.
- The student can apply the knowledge to understand the magmatic evolution

UNIT-I

1.1 Mantle as heat engine, nucleation and crystal growth, igneous rock series.
1.2 Magma and its generation; Melting Depth, mantle material, partial melting of the peridotitic mantle and magma generation in continental crust
1.3 Magmatic Differentiation (open and closed systems) and assimilation, Hybridization, magma storage, ascent

and emplacement, field relations of intrusions

1.4 Phase rule, Phase equilibrium studies of binary system with eutectic (Di-An), peritectic (Fo-Silica) and solid solution relation (Ab-An, Orthoclase-Albite) and ternary system (Di-Ab-An) and theirtheir application in describing textures and petrogenesis of various rock- types.

UNIT-II

2.1 Classification schemes of igneous rocks, IUGS classification of plutonic, hypabyssal and volcanic rocks,

2.2 Irvine-Baragar classification of volcanic rocks, classification of basalt: IUGS, Kuno, Yoder and Tilley, Macdonald and Katsura, Chayes, Pearce and Cann.

2.3 Mid Ocean Ridge Basalt (MORB) and its global correlation.

2.4 Large Igneous Provinces, mantle plumes and related magmatism. General idea on layered complex

UNIT-III

3.1 Petrogenesis and tectonic setting of major igneous rock types and suites: Ultramafic rocks, Komatiite, Ophiolites, Basalt and Anorthosite.

3.2 Petrogenesis and tectonic setting of Lamprophyres and Kimberlite.

3.3 Petrogenesis and tectonic setting of alkaline rocks and Carbonatite.

3.4 Petrogenesis and tectonic setting of Tonalite-Trondhjemite-Granodiorite (TTG), Granitoids and its derivatives and pegmatites.

UNIT-IV

4.1 Meteorites: Mineralogy and Classification. Meteorites: definition, age, importance of study; classification and its basis, mineralogical characteristics and contrast with terrestrial mineralogy, broad chemical characteristics, brief outline on origin

4.2 Origin of chemical elements and stellar evolution, Distribution of elements in core, mantle, crust. Geochemical differentiation of primordial earth.

4.3 Geochemical classification of elements:Washington's, Goldschmidt's, Kuhn and Ritmann

4.4 Significance of crystal chemistry in geochemistry, isomorphism and diadochy, camouflage, capturing and admission of trace elements. Partition coefficients

UNIT-V

5.1 Behaviour of major and trace during magmatic melting and crystallization and their application in petrogenesis and as tectonic discriminannts.

5.2 Rare earth geochemistry, general geochemical properties of REE's and their abundance and mobility in crust.

5.3 Radiogenic isotopes in geochronology and petrogenesis: Rb-Sr, Sm-Nd, U-Pb isotopic systems.

5.4 Stable isotopes: nature, abundance and fractionation. Application of stable isotopes in geological processes.

Books Recommended

1. Phillpotts, A.R. (1994) Principles of Igneous and Metamorphic Petrology, Prentice Hall of India.
2. Winter, J. D. (2014) Igneous and Metamorphic Petrology, Pearson Education Limited, Edinburg.
3. Best, M. G. (2003) Igneous and Metamorphic Petrology, 2nd Ed. Blackwell.
4. Bose, M.K. (1997) Igneous Petrology, World Press, Kolkata.
5. Cox, K. G., Bell, J. D. and Pankhurst, R. J. (1979) The Interpretation of Igneous Rocks, UnwinHyman.
6. McBirney, A. R. (1993) Igneous petrology. Jones & Bartlet Publication.
7. Allegre, C.J. and Michard, G. (1974) Introduction to Geochemistry, Reidel, Holland.
8. Evans, R.C. (1964) Introduction to Crystal Chemistry, Cambridge Univ. Press.
9. Faure, G. (1998) Principles and applications of geochemistry, 2nd Edn., Prentice Hall, New Jersy, 593p.
10. Faure, G. (1986) Principles of Isotope Geology, 2nd Ed. John Wiley.
11. Krauskopf, K.B. (1967) Introduction to Geochemistry, McGraw Hill.
12. Mason, B. and Moore, C.B. (1991) Introduction to Geochemistry, Wiley Eastern.
13. Sen, Gautam(2014) Petrology, Principles and practice

Course Code: P2AGTC104 | **Title: Applied Hydrogeology**
Credits: 04 | **Maximum Marks: 100**
Duration of Examination: 3hours | **(Minor I-20, Minor II 20, Major 60)**

(Syllabus for the examination to be held in Dec. 2025, Dec. 2026 & Dec. 2027)

Course Objectives: The course aims to provide students with a comprehensive understanding of the hydrologic cycle, water balance, and processes governing surface and groundwater flow. It equips the students with analytical tools and techniques for hydrologic data analysis, modeling, and water resource management. The course also emphasizes practical applications in flood forecasting, watershed management, and sustainable groundwater utilization.

Course Outcomes: At the completion of this course the students shall be able to

- Understand and apply fundamental and advanced concepts of hydrological processes, including precipitation, infiltration, runoff, groundwater flow, and watershed modeling
- Will develop skills in hydrological data analysis, use of hydrological models and water resource management

Unit- I:Fundamentals of Hydrology

1.1. Introduction to Hydrology: Hydrology and Its Importance, Hydrologic cycle, Origin and classification of water, Precipitation, infiltration, evapotranspiration, runoff, Types and measurement of precipitation.
1.2. Catchment storage concept, Excess rainfall, Direct runoff, Overland flow, Hydrological data sources and networks (IMD, CWC, CGWB), Rainfall-runoff relationships; hyetograph and hydrograph analysis.
1.3. Watershed characteristics and delineation, water balance studies and their applications.
1.4. Stream flow measurement: stage-discharge relationships, current meter, float method.

Unit- II:Surface Water Hydrology

2.1. Stream Hydrographs: Baseflow recession, storm hydrographs, gaining and loosing stream, measurement and representation of stream flow.
2.2. Flood hydrology: types, causes, frequency analysis, flood routing.
2.3. Linear system theory, Unit Hydrograph, Direct runoff hydrograph, S-Hydrograph, Unit hydrographs of different durations, Instantaneous unit hydrograph, Synthetic unit hydrograph.
2.4. Unit hydrographs for ungauged catchments, concept of Catchment modelling, Effect of rainfall intensity and duration on hydrograph

Unit- III:Fundamentals of Groundwater

3.1. Occurrence and distribution of groundwater, Aquifer types: confined, unconfined, perched, leaky aquifers.
3.2. Hydrological propertiesof rock-formations, Porosity, permeability, specific yield, specific retention, Hydrostratigraphic units, water table contour maps and flow net analysis.
3.3. Groundwater movement: Darcy's law, hydraulic conductivity, Unsaturated flow.
3.4. Groundwater quality: major ions, EC, pH, TDS, water quality standards (WHO/BIS), graphical presentation of water quality data.

Unit- IV:Exploration and Management of Groundwater

4.1. Groundwater exploration techniques: Subsurface geophysical method, well logging techniques for delineating aquifer thickness and estimation of groundwater quality; electric radiational both natural and induced caliper and temperature logs.
4.2. Different drilling methods used in the construction of water wells; Shallow, deep penetrating and non-penetrating types, various groundwater structures.
4.3. Groundwater balance and budgeting, Fracture trace analysis, pumping test methods, interpretation of data (Theis, Cooper-Jacob).
4.4. Artificial recharge methods and managed aquifer recharge (MAR), Water Resource Management Pricing of Water, Sustainable Development of Water.

Unit-V:Applied Aspects and Modelling in Hydrology

5.1. Basic introduction to hydrological and groundwater models (e.g., SWAT, MODFLOW).
5.2. Groundwater contamination: sources, transport, and remediation techniques.
5.3. Fundamentals of hydrologic design, Design storm, Design flood, Design flows, Storm sewer design.
5.4. Simulating Design flows, flood plain analysis, flood control reservoir design, flood forecasting, Design for water use.

Recommended Books:

1. Todd, D.K. & Mays, L.W. (2005). Groundwater Hydrology. Wiley.

2. Karanth, K.R. (1987). Groundwater Assessment, Development and Management. Tata Mc Graw Hill.
3. Raghunath, H.M. (2007). Hydrology: Principles, Analysis and Design. New Age International.
4. Subramanya, K. (2017). Engineering Hydrology. McGraw-Hill.
5. Singh, V.P. (1992). Elementary Hydrology. Prentice Hall.
6. Alley, W\.M. (1993). Regional Ground-Water Quality. Van Nostr and Reinhold.
7. Chow, V.T. (1964): Handbook of Applied Hydrology. New York: McGraw Hill Book Co.
8. Charles R. Fitts (2013): Groundwater Science, Academic press.
9. Fetter C.W (2001): Prentice Hall International (UK) Limited, London.

Course No.: P2AGTC105
Credits: 02
Duration of Examination: 2 ½ hours

Title: Applied Mineralogy
Maximum Marks: 50
(Minor I-10, Minor II 10, Major 30)

(Syllabus for the examination to be held in Dec. 2025, Dec. 2026 & Dec. 2027)

Course Objectives: This course offers the broader understanding to the field of mineralogy by imparting the basic knowledge about the rock forming minerals, their formation, complexity, associations, identification and allied technical contexts. The course also provides an introduction to mineral characterization techniques and highlights the industrial applications of key minerals.

Course Outcomes: After completing this course, students will be able to:

- Understand the fundamental properties, structures, and classifications of minerals and crystals.
- Interpret light-matter interactions and identify minerals using optical techniques.
- Apply principles of optical mineralogy to distinguish uniaxial and biaxial minerals.
- Classify non-silicate and silicate mineral groups based on structure, properties, and paragenesis.
- Utilize advanced analytical tools (XRD, XRF, SEM etc.) for mineral identification and characterization.
- Carry out analytical work on rock/ mineral samples, thin sections and powdered materials.

UNIT I – Optical Mineralogy

1.1 Light-matter interaction: isotropic vs. anisotropic minerals. Optical phenomena—color, refraction, reflection, TIR, refractive index. Light behavior—phase, interference, colors, retardation, resolution.
1.2 Polarization: methods, uses. Polarizing microscope and accessories.
1.3 Extinction: types, causes, measurement, uses. Refractive index determination.
1.4 Optical Indicatrix: uniaxial and biaxial—construction and applications. Interference figures (Uniaxial & Biaxial): types, parts, formation, and uses. Optic angle (2V) measurement;

UNIT II – Descriptive mineralogy

2.1 Minerals as solid solutions; Principles governing solid solution mineral chemistry phenomena.
2.2 Structure of silicate minerals. Bearing of structure on certain properties of minerals
2.3 Classification, features, and paragenesis of Oxides & hydroxides, Sulfates&sulfides, Carbonates & phosphates and atomic minerals
2.3 Brief idea on the internal structure of Pyroxene, Amphibole and Mica (with relevant classification schemes) and site- occupancy of cations.
2.4 Mica & Clays: structure, classification, paragenesis.

UNIT III – Silicate Minerals and Transformations

3.1 Olivine: Brief structural characters, classification, anti-ordering in olivine, olivine- spinel transitions and its geodynamic significance.
3.2 Spinel Group: Different types of spinels and their internal structures.
3.3 Feldspar Group : internal structure, Alkali Feldspar, Plagioclase Feldspar and ternary feldspar, proportion of Al- occupancy in T sites in KAlSi3O8; degree of ordering, 2V as an indicator of ordering in K- feldspar, polymorphism of $NaAlSi_3O_8$, ordering paths in albite, structural states of plagioclase, obliquity of K- feldspar
3.4 Nepheline: Constitution of Nepheline, compositional non- stoichiometry, nephelines of volcanic and plutonic /metamorphic origin, nature of Al- Si ordering, vacant site from chemical analysis of nepheline.

UNIT IV – Mineralogical Techniques

4.1 Principles of X- ray powder methods, Bragg Equation and its application, different types of bonding, co-ordination principle and co-ordination numbers,
4.2 X–ray camera: diffractrogram, procedure for identification of minerals from x-ray powder diagram, use of internal standards.
4.3 Application of SEM, TEM and EPMA in mineral characterization.

4.4 Fundamentals of Crystal Field Theory, concept of stabilization energy, Application of crystal field Theory in determining mineral structure.

Books Recommended

1. Mukherjee, S. — Applied mineralogy: Applications in Industry & Environment.
2. Nesse, W.D. — Introduction to Mineralogy
3. Putnis A. — An introduction to mineral sciences
4. Whalstrom, E. E. — Optical Crystallography
5. Nesse, W.D. — Introduction to Optical Mineralogy
6. Dana, E.S . — A Textbook of Mineralogy
7. Mitra, S. — Fundamentals of Optics Spectroscopic & X-ray Mineralogy
8. Ehelrs, E.G. — Optical Mineralogy
9. Kerr, P.F. — Optical Mineralogy
10. Naidu, P.R.J . — Optical Mineralogy
11. Philips, W.R. — Mineral Optics
12. Sholley, P. — Manual of Optical Mineralogy
13. Winchel, A.N — Elements of Optical Mineralogy
14. Mckie, D. &Mckie, C. — Crystalline Solids
15. Wolfson M.M. — X-Ray Crystallography
16. Deer, Howie &Zussman. — An introduction to the rock forming minerals
17. Cerreves . — Introduction to mineralogy
18. Berry and Masons. — Mineralogy
19. Kestov . — Mineralogy
20. Batckhtin . — Mineralogy
21. Vema, P K . — Optical Mineralogy Ane Book Pvt Ltd. Delhi
22. Sharma, R and Sharma A. — Crystallography and Mineralogy: Concepts and Methods GSI

Course Code: P2AGPC106 **Practical related to Course No.: 101, 102, 103, 104, 105**

P2AGPC101: Practical hand on stratigraphic columns, facies diagrams and correlation charts from field data. Making of fence diagrams from borehole data, calculation of bed thicknesses using trigonometric techniques, development of composite lithologs. Identification and division of lithocolumn into Group, Formation, Members, Beds etc,

P2AGPC102: Geometric methods used to interpret geological structures, completion and interpretation of geological maps, strain analysis, palaeostress analysis

P2AGPC103: Megascopic and microscopic studies of major igneous rock types. CIPW norm calculation. Introduction to software: Sinclass, Petrograph, and GCD kit. Preparation of Solution A and Solution B; determination of various major oxides by titration methods; determination of alkali elements by Flame photometer; determination of elements by UV/VIS spectrophotometer.

P2AGPC104: Rainfall and Stream flow Data Analysis: Plotting hyetographs, hydrographs, flow-duration curves, Water Sampling & Quality Testing*: TDS, pH, EC, hardness, major cations/anions, Aquifer Parameter Estimation : Analysis of pumping test data using Theis and Cooper-Jacob methods.

P2AGPC105: Identification of important rock forming minerals in hand specimen and their physical properties; preparation of thin-section from bulk rock samples; determination of various optical properties and identification of rock forming minerals under polarizing microscope and optic sign determination of uniaxial and biaxial minerals; pleochroic scheme determination of minerals using polarizing microscope; staining technique for identification of carbonate minerals; X-ray diffraction related computations.

Course No P2AGPC107

Weekend Geological Fieldwork **Credits:2** **Max. Marks: 50**

This course shall comprise of 5-7 day's weekend field work. The students shall have experiential learning on toposheet reading, field mapping techniques, identification of rocks, structures, lithology, stratigraphy etc. At the end the students shall submit a comprehensive field report. The distribution of marks shall be as follows:

Attendance: 10%
Performance during the fieldwork: 20%
Field Report: 60%
Viva-voce at the time of external examination: 10%

SEMESTER - II

Course No.: P2AGTC201 | **Title: Sedimentology: Processes & Petrology**
Credits: 04 | **Maximum Marks: 100**
Duration of Examination: 3 hours | **(Minor I-20, Minor II 20, Major 60)**

(Syllabus for the examination to be held in May 2026, May 2027 & May 2028)

Course Objectives: The course shall help students to understand the processes involved in the formation of sedimentary rocks and their petrogenesis.

Course Outcomes: This course typically explores the fundamental processes responsible for formation of sedimentary rocks, their characteristics, classification and petrogenesis.

UNIT-I Sediments and sediment analysis

1.1 Formation and nature of sediments, formation of sedimentary rocks
1.2 Sediment analysis: grain size (techniques of size analysis, grade-scale, phi-scale;) grain morphology (shape forms, sphericity, roundness; grain fabric).
1.3 Graphical representation, application and uses of grain size data; Textural parameters and their significance
1.4 Indicators of sediment maturity: mineralogy and textures; surface textures and their significance

UNIT-II Sedimentation: sediment transport and deposition

2.1 Fluid motion, forces acting on fluids, basic properties of fluids and flow types
2.2 Streamlines, flow separation, flow regimes
2.3 Sediment transport modes; sediment gravity flow: mud flow, grain flow, liquefied flow, turbidity flow
2.4 Porosity and permeability, pore morphology, effect of texture on porosity and permeability

UNIT-III Sedimentary structures

3.1 Nature and significance of bedding, Graded beds, stability of bedforms
3.2 Primary Sedimentary structures: Formation and significance
3.3 Sole marks: types, mode of formation, significance
3.4 Deformational sedimentary structures and their significance

UNIT- IV Sedimentary rocks: classification & petrology

4.1 Classification and petrogenesis of clastic sedimentary rocks (rudaceous rocks, arenaceous and argillaceous rocks)
4.2 Nomenclature and Classification of carbonate rocks (Folk and Dunham)
4.3 Carbonate rocks and their allochemical and orthochemical constituents, Dolomitization, Dedolomitization
4.4 Diagenesis of sedimentary rocks

UNIT- V Petrogenesis & Depositional Environments

5.1 Petrogenesis of biogenic silica and phosphate deposits
5.2 Petrogenesis of Evaporites
5.3 Heavy minerals and their significance
5.4 Introduction to sedimentary depositional environments

Books Recommended

1. Miall, Andrew D. — Principles of Sedimentary Basin Analysis
2. Lindholm, R. C. — A Practical Approach to Sedimentology
3. Collinson, J. D. & Thompson, D. B. — Sedimentary Structures
4. Reineck, H. E. & Singh, I. B. — Depositional Sedimentary Environments
5. Allen, J.R.L. — Physical processes of Sedimentation
6. Reading, H.G. — Sedimentary Environments
7. Petijohn, F.J. & Potter — Sand and Sandstone
8. Petijohn, F.J — Sedimentary rocks
9. Friedman, M.Gorale& Sanders — Principles of Sedimentology
10. Selley, R.C. — Applied Sedimentology
11. Blatt, Middleton and Murray — Carbonate sediments and their origin
12. Bathurst, R.G.C. — Carbonate sediments and their diagenesis
13. Miall, A D. — Fluvial Depositional System

Course No.: P2AGTC202
Credits: 04
Duration of Examination: 3 hours

Title: Applied Palaeontology
Maximum Marks: 100
(Minor I-20, Minor II 20, Major 60)

(Syllabus for the examination to be held in May 2026, 2027, 2028)

Course Objectives: To understand the basic principles of organic evolution and their application in palaeontology and to have an extensive knowledge of evolution and distribution of the important invertebrate, vertebrate, trace and plant fossils and their significance

Course Outcomes: On successful completion of the course the student will be able to

- Know about evolutionary processes, taphonomy and cladistics
- Appreciate the role of climatic and environmental factors in the evolution, extinction and diversification of various taxonomic groups
- Able to analyse the role of plate tectonics in the distribution of varied groups and comprehend the evolution of biota during the northward drift of the Indian plate
- Interpret the significance of fossils in understanding the earth's history and biological evolution
- Apply fossils to decipher climate, ecology and environment of the past

UNIT-I

1.1 Nature of the fossil record –preservation, taphonomy, sampling, and temporal changes
1.2 Evolutionary process and the fossil record - micro and macroevolution, heterochrony
1.3 Hennigian systematics. Fossils, molecular clocks and estimation of divergence time
1.4. Major bio events and the geological time scale / Mass extinctions – patterns, selectivity, timing, periodicity and causes.

UNIT-II

2.1 Echinoderms and trilobites – geological distribution and significance
2.2 Gastropods, ammonoids and cephalopods – geological distribution and significance
2.3 Brachipods and bivalves – geological distribution and significance
2.4 Bryozoans and graptolites – geological distribution and significance

UNIT-III

3.1 Ichnofossils and their application in geological studies
3.2 Key steps in the evolution of plants. Gondwana floras of India and their significance. Application of palaeobotany in palaeoclimatic studies
3.3 General characters of vertebrates and various classes, and their origin
3.4 Fossils and the evolutionary events in the geological history of the vertebrates: evolution of bone and cartilage, jaw and teeth, transition from water to land, development of amniote egg

UNIT-IV

4.1 Rise and fall of dinosaurs, their diversity and thermoregulation
4.2 Origin of birds, *Archaeopteryx*, birds as dinosaurs
4.3 Palaeobiogeography – vicariance and dispersals. Gondwana and Deccan vertebrates of India and their palaeobiogeographic significance
4.4 Palaeogene hyperthermal events and emergence of modern mammalian orders. Indian Palaeogene mammalian record and biogeography

UNIT-V

5.1 Whale evolution as a poster child for macroevolution
5.2 Systematic, phylogeny, and evolution of horse and proboscideans and the climatic implications in their evolution and distribution
5.3 The fossil trail: how we know what we know about human evolution and lithic cultures
5.4 Siwalik mammalian faunal changes and their relation to tectonic and eustatic events. Pleistocene megafaunal extinctions

Recommended Books

1 Morley Davis & Stubblefield, S.J. 1962. Introduction to Palaeontology. T. Murby.
2 Shrock, R.R &Twenhofel, W.H. 1953. Principles of Invertebrate Palaeontology. 2nd edition. McGraw-Hill
3 Black, R.M. 1989. The Elements of Palaeontology. Cambridge University Press.
4 Fairbridge& Jablonski 1979. The Encyclopedia of Palaeontology. Dowden, Hutchinson & Ross, Academic Press, Stroudsburg.

5 Babin, C. 1980. Elements of Palaeontology. Wiley–Blackwell.
6 Clarkson, E. K. 2013. Invertebrate Palaeontology and Evolution. Blackwell Science.
7 Raup, D.M. & Stanley, S.M. 1971. Principles of Palaeontology. W. H. Freeman & Co.
8 Lull, R.S. 1917. Organic Evolution. Macmillan, New York.
9 Dodd, J.R. & Stenton, R.J. 1990 Palaeoecology-Concept and Applications. Wiley
10 Frey, R.W. 1975. The study of trace fossils. Springer Nature
11 Bromley, R.G 2016. Trace Fossils. Routledge.
12 Seilachers. A. 2007. Trace Fossils Analysis. Berlin, Heidelberg, New York: Springer-Verlag.Amal Dasgupta 2016. Introduction to Palaeontology. The World press Private Limited.
13 A.E. Romer & T.S. Parsons. 1977. The Vertebrate Body. 5th edition. Saunders, Philadelphia, PA.
14 E.H. Colbert. 1980. Evolution of the Vertebrates – A history of the backboned animals through time. John Wiley & Sons.
15 M.J. Benton & D. Harper. 1997. Basic Palaeontology. Pearson Education Ltd.
16 R.L. Carroll. 1997. Pattern and Processes of Vertebrate Evolution. Cambridge University Press.
17 M. Hildebrand & G.E. Goslow. 2001. Analysis of Vertebrate Structure. John Wiley & Sons, Inc.
18 M.J. Benton. 2005. Vertebrate Palaeontology. Blackwell Science Ltd.
19 D. E. Fastovsky& D. B. Weishampel. 2016. Dinosaurs: a concise natural history. The Johns Hopkins University

Course No.: P2AGTC203 **Title: Geospatial Techniques**
Credits: 04 **Maximum Marks: 100**
Duration of Examination: 3 hours **(Minor I 20, Minor II 20, Major 60)**

(Syllabus for the examination to be held in May 2026, 2027, 2028)

Course Objectives: Remote Sensing Technology has emerged as an important tool for scientifically managing resources and environment. The technology enhanced our capability of resources exploration, mapping and monitoring on local and global scale. This course has been designed with the objectives to acquaint the students with basic principles of remote sensing, GIS and GPS.

Course Outcomes: On successful completion of the course the students will be able

- To become aware about the fundamental concept of Remote Sensing, interaction of EMR with atmosphere and earth's surface, platforms- aerial and space borne characteristics, satellites and their characteristics.
- Principles of active and passive sensors, sensors types and their characteristics, optical imaging sensors, concept of resolution, steps and elements of image interpretation.
- To understand multidate, multispectral and multiresolution concepts, instruments for visual interpretation.
- To enables the students to learn the basic professional skills pertaining to concept of digital image, digitization of photographic image, image visualization, digital image data formats, image data storage.
- To understand the fundamental concept of Geographical Information Systems (GIS), computer fundamentals for GIS, hardware and software requirements for GIS.
- To understand the basic concepts of Global Positioning System (GPS), its components, working, and applications in different field.
- To broaden the horizon of the students about the digital cartography, its elements and to substantiate the photogrammetry concepts.

UNIT-I Geospatial Technology-concept and overview

1.1 An Overview of geospatial technology, developments of remote sensing, advantages and limitations of remote sensing techniques.
1.2 Define the basic principles of satellite remote sensing: Electromagnetic Radiation (EMR) and electromagnetic spectrum, earth and atmospheric interaction with EMR
1.3 Remote sensing: data resources, platforms and sensors acquisition of remote sensing data.
1.4 Satellite remote sensing, global and Indian space mission. Different satellite explorationprograms and their characteristics: LANDSAT, METEOSAT, SPOT, JERS-I, IRS.

UNIT-II Aerial photography

2.1 Introduction to aerial photography – Basic information and specifications of aerial photographs
2.2 Aerial camera, lens, types of aerial photographs and information records on the aerial photographs. Planning and execution of photographic flights
2.3 Geometry of the aerial photographs, stereoscopic vision and stereoscope. Measurement of the height difference from aerial photographs.

2.4 Recognition of photo-elements and terrain elements like tone, texture, pattern, shape, size; terrain elements like drainage pattern, density, type, landform characteristics, erosion behavior of rock and soil material, vegetation and landuse.

UNIT-III Thermal and Microwave Remote Sensing

3.1 Introduction, TIR region of electro-magnetic spectrum, thermal properties of material.
3.2 Interpretation of thermal (radiant temperature) imagery, interpretation of day and night thermal image, advantage of thermal imagery.
3.3 Introduction, advantage of microwave remote sensing, microwave sensors, radar operating principle.
3.4 Spatial resolution of SLAR system, geometric characteristic of SLAR imagery, transmission characteristic of radar signals, radar return and image characteristic, interpretation of radar image and general application microwave remote sensing.

UNIT-IV Digital Image Processing

4.1 Introduction to digital image processing- concept of digital image, steps in DIP& Image processing systems - hardware and software
4.2 Fundamental of image rectification, definition, principle and procedure, Radiometric & geometric correction of remotely sensed data.
4.3 Image enhancement techniques Contrast enhancement, equalization and densityslicing, Spatial filtering and edge enhancement
4.4 Image classification types - supervised and unsupervised, advantage and limitations

Unit-V Geographical Information System

5.1 Introduction to GIS - definition, concept and history of developments in the field of information systems
5.2 Components of geographical information system (GIS), database structures in raster and vector and its comparison.
5.3 Global Positioning System (GPS) and its segments, observation principle, parameters affecting the accuracy of result, main components of a GPS receiver and GPS application.
5.4 Digital cartography - elements of digital cartography, relation between digital cartography and photogrammetry

Books Recommended

1. Campbell, J.B.2002: Introduction to Remote Sensing. Taylor Publications
2. Drury, S.A., 1987: Image Interpretation in Geology. Allen and Unwin
3. Gupta, R.P.., 1990: Remote Sensing Geology. Springer Verlag
4. Jensen, J.R. 2000: Remote Sensing of the Environment: An Earth Resource Perspective. Prentice Hall.
5. Joseph George, 2003: Fundamentals of Remote Sensing. Universities Press
6. Lillesand, T.M., and Kieffer, R.M., 1987: Remote Sensing and Image Interpretation, John Wiley.
7. Ram Mohan Rao. 2002: Geographical Information Systems. Rawat Publication.
8. Skidmore A.2002: Environmental Modeling with GIS and Remote Sensing. Taylor and Francis
9. Tar Bernhardsen. Geographical Information Systems. John Wiley.
10. Wise S.2002: GIS Basics. Taylor Publications
11. Sabbins, F.F., 1985: Remote Sensing Principles and interpretation. W.H. Freeman and company
12. Anji Reddy, M. 2004: Geoinformatics for Environmental Management.B.S. Publications
13. Rampal K.K. 1999: Hand book of Aerial Photography and Interpretation. Concept Publication
14. Paul R Wolf 2014; Elements of Photogrammetry
15. Mishra R.P and Ramesh A. 1989: Fundamentals of Cartography. Concept Publishing Company

Course No.: P2AGTC204 **Title: Metamorphic Petrology**
Credits: 02 **Maximum Marks: 50**
Duration of Examination: 2 ½ hours **(Minor I-10, Minor II 10, Major 30)**

(Syllabus for the examination to be held in May 2026, May 2027 & May 2028)

Course Objectives: The Course aims to make to the students well-versed with the strength of Metamorphic Petrology, including different petrogenetic processes involving mineral reactions and equilibrium thermodynamics.

Course Outcomes:

- Students will acquire a comprehensive understanding of metamorphism and types of metamorphic rocks

- Students will learn thermodynamic principles related to metamorphic petrology, applicable to a number of orogenic events in time and space
- Students will be able to estimate Pressure-Temperature conditions of metamorphic rocks especially those formed during orogenesis.

UNIT-I

1.1 The Common minerals of metamorphic rocks, Concept of equilibrium in metamorphic systems; Gibbs phase rule and Mineralogical Phase Rule and their application in simple and complex systems.
1.2 Graphical representation of metamorphic mineral assemblages in different P-T conditions.
1.3 Schreinemakers rules and Petrogenetic grid for metamorphic assemblages in various grades of metamorphism.
1.4 Time relation between phases of deformation and metamorphic crystallization.

UNIT-II

2.1 Metamorphic Isograds and Zones, Concept and classification of metamorphic facies; Facies series
2.2 Description of facies of low pressure with special reference to characteristics minerals, mineral assemblages, metamorphic reactions and pressure-temperature conditions of metamorphism

2.3 Description of metamorphic facies of medium to high pressure with special reference to characteristics minerals, mineral assemblages, metamorphic reactions and pressure-temperature conditions of metamorphism.
2.4 Description of UHT and UHP metamorphism with special reference to characteristics minerals, mineral assemblages, metamorphic reactions.

UNIT-III

3.1 Heat flow and metamorphism: Paired Metamorphic belt, Schematic diagrams to illustrate the origin of paired metamorphic belts.
3.2 Ocean floor metamorphism and its types
3.3 Impact metamorphism
3.4 Anatexis and origin of migmatites

UNIT-IV

4.1 Metamorphic differentiation.
4.2 Characterization of metamorphic fluids and mineral-fluid equilibria, metasomatism
4.3 Metamorphic P-T-t paths and tectonic evolution. Geothermometry and Geobarometry
4.4 Plate tectonics and metamorphism

Books Recommended

1. Turner, F.J. (1980)Metamorphic Petrology, McGraw Hill, New York.
2. Yardlley, B.W.D. (1989) An introduction to Metamorphic Petrology, Longman Scientific and Technical, New York.
3. Philopotts, A.R. (1994) Principles of Igneous and Metamorphic Petrology, Prentice Hall.
4. Kretz, R. (1994) Metamorphic Crystallization, John Wiley.
5. Bucher, K. and Frey, M. (2002) Petrogenesis of Metamorphic Rocks (7th Rev. Ed.), Springer–Verlag.
6. Powell, R. (1978) Equilibrium thermodynamics in Petrology: An Introduction, Harper and Row Publ., London.
7. Wood, B.J. and Fraser, D.G. (1976) Elementary Thermodynamics for Geologists, Oxford University Press
8. Spry, A. (1976) Metamorphic Textures, Pergamon Press.
9. Winter, J.D. (2001) An introduction to Igneous and Metamorphic Petrology, Prentice Hall.
10. Sharma, Ram S. (2017) Metamorphic Petrology, Geological Society of India, Bangalore

Course No.: P2AGTC205
Credits: 04
Duration of Examination: 3 hours

Title: Geo-Exploration and Mining Geology
Maximum Marks: 100
(Minor I-20, Minor II 20, Major 60)

(Syllabus for the examination to be held in May 2026, May 2027 &May 2028)

Course Objectives: It is intended to familiarize the students with the principles, methodology and application of important geophysical and Geochemical methods adopted to investigate the surface and subsurface. To introduce the concept of exploratory mining methods.

Course Outcomes: After studying this course, students will be able to

- Understand the principles and methods of geological and geochemical exploration.
- Ascertain industrial and non industrial resources and distinction between reserve and resource.
- Apply geophysical techniques like gravity, electric, magnetic etc for subsurface investigations and their data interpretations.
- Develop a technical understanding of various mining techniques, their development and operations.

UNIT-I Geological and Geochemical exploration

1.1 Mineral exploration: Selection of area for prospecting. Stages of geological prospecting, Geological guides for the prospecting of mineral deposits; mineralogical, lithological and structural guides, gossans and capping.

1.2 Geochemical exploration Principle: mobility and geochemical association of elements. Primary and secondary geochemical dispersion patterns.

1.3 Methods and applications of geochemical exploration. Treatments of geochemical data.

1.4 Geobotanical survey: Uptake of mineral matters by plants, geobotanical indicators, geobotanical survey techniques. Biogeochemical anomalies and biogeochemical method of exploration.

UNIT-II Sampling methods, mineral resource classification and ore reserve estimation

2.1 Geological aspects of pitting, trenching and common drilling techniques.

2.2 Sampling and assaying: Theory, patterns and methods. Core logging and core sampling.

2.3 Resources and Reserves: Identified and Unidentified Resources, Measured, Indicated and Inferred Reserves, Para-marginal, Sub-marginal, Hypothetical and Speculative Resources; Classification Schemes, viz. USGS and UNFC Schemes.

2.4 Evaluation of exploration data and ore reserve estimation. Introduction to geostatistical estimation of reserves.

UNIT-III Exploration Geophysics I

3.1 Gravity method - basic principles. Earth's gravitational field and its relation to geophysical exploration. Instruments used in gravity prospecting - pendulum, torsion balance and gravimeters.

3.2 Reduction of gravity data, separation of regional and residual gravity anomalies and interpretation of gravity data.

3.3 Gravity corrections: Free-air correction, Bouguer correction, Latitude correction, Terrain correction

3.4 Magnetic method: Geomagnetic field, Induced magnetism, Remnant magnetism, Susceptibility, Field survey method, Equipment, Data processing, Qualitative and quantitative interpretation of magnetic data.

UNIT-IV Exploration Geophysics II

4.1 Electrical Methods: Electrical properties of rocks, Flow of current through ground surface, Apparent resistivity, Field procedures and electrode arrangements, VES and CST and their qualitative interpretation. Electromagnetic spectrum and induction,

4.2 Seismic Methods: Basic principles, Types of seismic waves and their propagation characteristic, Seismic velocities in Earth's materials.

4.3 Refraction technique - Time distance relations for horizontal interface, dipping beds and faults. Delay time, shot and detector arrangement and corrections.

4.4 Reflection technique - Time distance relations for horizontal and dipping interfaces, shooting procedures and corrections applied to reflection records.

UNIT-V Elements of mining

5.1 Introduction to mining, definitions and explanation of different mining terminology.

5.2 Introduction to Surface mining; deposits amenable to surface mining;Classification of surface mining systems.

5.3 Introduction to underground metal mining; deposits amenable to underground metal mining. Modes of entry to underground mineral deposits. Mine development: drifting, raising and winzing; Classification of underground metal mining methods. General description, applicability and operations involvedin different methods.

5.4 Introduction to underground coal mining:Broadclassificationof underground coal mining methods. Board and Pillar method, Logwall mining methods –general description and its advantages and disadvantages.

Books Recommended

1. Govett, G.J.S. (1983) Rock Geochemistry in mineral exploration, Vol.3.Elsevier Scientific Publishing Company.

2. Govett, W.K., Hoffman, S.J., Merthens, M.B., Sinclair, A.J. and Thomson, I. (1987). Exploration Geochemistry, Design and Interpretation of Soil Survey.Reviews in Economic Geology, Vol.4.
3. Hale, M. and Plant, J.A. (1994) Handbook of Exploration Geochemistry – Drainage Geochemistry, vol 6,Elsevier Scientific Publishing Company.
4. Levinson, A.A. (1974) Introduction to Exploration Geochemistry, Applied Publishing Ltd. USA.
5. Reedman, J. H. (1979) Techniques in mineral exploration.Applied Science Publishers.
6. Rose, Arthur W., Herbert, E. Hawkes and Webb, John S. (1979) Geochemistry in Mineral Exploration. Acad Press.
7. Evans (1998) Introduction to Mineral Exploration.*Blackwell Science*
8. McKinstry, H.E. (1967) Mining Geology, Prentice Hall,
9. Clark, G.B. (1967) Elements of Mining, III ed. John Wiley
10. Arogyaswami, R.P.N. (1996) Courses in Mining Geology, IV Ed. Oxford IBH
11. Garland GD (1979) Introduction to Geophysics. *W.B. Saunders Company*
12. Nettelton, L.L. (1976) Gravity and Magnetics in oil prospecting.*McGraw-Hill*
13. Dobrin, M.B. (1988) Introduction to Geophysical Prospecting. *McGraw-Hill*& C.H. Savit
14. Ramakrishna,T.S. (2006) Geophysical Practice in Mineral Exploration and Mapping.
15. Gandhi, S.M. & Sarkar, B.C. (2016) Essentials of mineral exploration and evaluation
16. Haldar, S.K. (2018) Mineral Exploration: Principles and Applications

Course No.: P2AGTC206 **Title: Earth Surface Features and Processes**
Credits: 02 **Maximum Marks: 50**
Duration of Examination: 2½ hours **(Minor I-10, Minor II 10, Major 30)**

(Syllabus for the examination to be held in May 2026, May 2027 & May 2028)

Course Objectives: To introduce the fundamental concepts governing the landforms; understand the concept of various geomorphological processes and landform evolution. Introduce the latest concept of chronology based on geomorphological studies in tectonic zones.

Course Outcomes: After studying this course, students will be able to

- Understand different land-forming processes that involve the shaping of earth surface structures over geological times
- Able to recognize different stages of landform cycles and their associated landforms through various geomorphological processes
- Understand how endogenic and exogenic forces played a major role in the evolutionary history of the Himalayas, Thar Deserts, and Western Ghats of Peninsular India

UNIT-I

1.1 Historical background of Geomorphology.
1.2 Lithological and structural control on landforms.
1.3 Qualitative and quantitative analysis of basins and drainage density.
1.4 Landform evolution by fluvial process

UNIT-II

2.1 Landform evolution by aeolian activity in hot arid regions
2.2 Landform evolution by marine processes
2.3 Glacier, types, and landform generation by glacial and fluvio-glacial processes
2.4 Morphometric parameters of mass movement deposits.

UNIT-III

3.1 Factors of weathering-mechanical disintegration, chemical decomposition.
3.2. Determination of weathering indices and ratios
3.3 Soils - soil formation and climate
3.4 Process of pedogenesis

UNIT-IV

4.1 Introduction to planetary geomorphology.
4.2 Morphotectonic evolution of Himalaya and Tibetan Plateau.
4.3. Evolutionary history of Thar Desert of India.
4.4 Morphotectonic evolution of Western Ghats of India.

Books Recommended

1. F.A. Pitty Introduction to Geomorphology
2. Donj-Easterbrook Principles of Geomorphology
3. C. Ollier Tectonics and Landforms
4. C. Ollier Weathering
5. Thornbury Geomorphology
6. A. Bloom Fluvial Geomorphology
7. C.A.M. King Introduction to Marine Geology and Geomorphology
8. K.S. Valdiya Aspects of Tectonics
9. Ronald Greeley Introduction to Planetary Geomorphology
10. R Greeley Planetary Landscapes

Course No.: P2AGPC207 **Title: Practicals related to 201,202,203,204, 205**
Credits: 04 **Maximum Marks: 100**
Duration of Examination: 4 hours

P2AGPC201 Megascopic and microscopic study of clastic and non-clastic sedimentary rocks; Textural analysis of sedimentary rocks.

P2AGPC202 Application of zoological code of nomenclature for taxonomic studies. Study of mega and microfossils of various invertebrate, vertebrate and plant groups. Study of modes of fossil preservation. Univariate and bivariate analysis of fossils using regression analysis and major axis equations. Cladogram construction.

P2AGPC203 Stereo test. Study of Aerial Photographs, resolution, mosaics, symbols, gully pattern and drainage analysis, image parallax. Determination of scale, height, dip, slopevertical exaggeration and image distortion; Visual interpretation of satellite imagery for geological structural geomorphic and hydro-morphological mapping; Exercises on digital image processing; Geometric correction and mosaicing of image; Vector functions - Spatial & attribute query; Data import and export; Geometric & Radiometric correction; Unsupervised classification; Supervised classification; Familiarization with ARC GIS software; Geo-referencing in ARC GIS; Digitization and layer creation; Data input, data editing and topology creation; Editing the &generation of Thematic layers Familiarization with GNSS receiver and to know the set up unit; Initialisation of the system in the field

P2AGPC204 Megascopic and microscopic studies of important metamorphic rocks with reference to texture/structure, time relation between phases of deformation and metamorphic crystallization, mineral association, parent rock, metamorphic facies to which rock can be assigned; Representation of assemblage in ACF, AKF and AFM.

P2AGPC205 Simple reserve estimation problems; Borehole correlation; Geochemical anomaly maps and its interpretation; Applying gravity corrections and preparation of gravity anomaly graphs for geophysical interpretation; Using seismic data from geophones to generate distance-time graphs and estimate subsurface stratigraphy.

SEMESTER - III

Course No.: P2AGTC301
Credits: 04
Duration of Examination: 3 hours

Title: Applied Micropalaeontology and Oceanography
Maximum Marks: 100
(Minor I-20, Minor II 20, Major 60)

(Syllabus for the examination to be held in December 2026, 2027, 2028)

Course Objectives:
1. To provide working knowledge of various microfossil groups and their geological significance
2. To study the modern concepts, dynamics and resources of the marine realm

Course Outcomes: Upon completion of this course the students will be able to

- Identify various microfossils
- Learn techniques for sampling, separating, and analyzing microfossils
- Apply microfossils in palaeoenvironmental, palaeoclimatic and palaeooceanographic studies, and hydrocarbon exploration
- Acquire a comprehensive understanding about oceans, their evolution, topography, sediments and dynamics
- Gain insights into the various resources of the marine realm and potential threats to it

UNIT-I

1.1 Microfossils - introduction, record, important groups. Microfossil sampling, techniques of separation; microfossils picking and mounting
1.2 Morphology, classification and geological significance of Ostracoda
1.3 Morphology, classification and geological significance of Foraminifera
1.4 Morphology, classification, distribution and geological significance of Radiolaria and Diatoms

UNIT-II

2.1 Morphology, classification, distribution and geological significance of Coccolithophores
2.2 Conodont: composition, elements, groups, apparatus and assemblages, biological affinities, history and geological significance. Pteropods and tentaculitids and their geological significance
2.3 Morphology, classification, distribution and geological significance of Acritarchs and Chitinozoans
2.4 Morphology, classification, distribution and geological significance of Dinoflagellates

UNIT-III

3.1 Morphology, classification, and geological significance of Charophytes Charophytes: morphology, classification, ecology and significance
3.2 Palynomorphs: Spores and pollens morphology (shape, aperture, composition and structure, sculpture, size) and their application. Phytoliths and their significance
3.3 Microfossils and biostratigraphy – biozones, biozonation, stratigraphic correlation and problems in biostratigraphic interpretations.
3.4 Application of microfossils in palaeoenvironment, palaeoclimate and palaeooceanographic studies and hydrocarbon exploration

UNIT-IV

4.1 Oceanography- origin and evolution of oceans; palaeoceanography – Palaeozoic, Mesozoic and Tertiary. Sea level fluctuations and their causes
4.2 Topographic features of the ocean floor. Hpsography of the continents and ocean floor. Classification of marine sediments, sediment budget, transport, accumulation. Coral reefs
4.3 Origin and evolution, structure and physiography, bathymetry and sediments of the Indian Ocean.
4.4 Wave dynamics: deep water, shallow water, wind waves; wave reflection, refraction and diffraction. Tides: equilibrium and dynamic theory, tidal currents in coastal areas, observation and prediction. Seiches and Tsunamis

UNIT-V

5.1 Heat budget and Atmospheric Circulation. Storms, jet streams, El Nino and land effects on winds. Ocean circulation: forces driving currents. Surface currents and their effects on climate
5.2 Thermohaline circulation and global heat connection. Wind induced vertical circulation. Seawater chemistry and dissolved gases. Density structure of ocean and stratification
5.3 Phytoplankton dynamics in the marine food web and factors limiting productivity. Marine physical and biological resources
5.4 Marine pollution – pollutants, habitat destruction and global changes (ozone layer depletion, global warming, acid rain)

Recommended Books

1. Danial J. Jones 1956 Introduction to Microfossils. Harper and Brothers, Harper Geoscience Series
2. M.D. Brasier 1980 Microfossils. George Allen & Unwin
3. Gerard Bignot 1985 Elements of Micro Palaeontology. Graham Trotman Limited
4. David G. Jenkins (Ed) 1993 Applied Micropalaeontology. Kluwer Academic Publishers
5. P.K. Kathal 1998 Microfossils and their applications. CBS Publishers
6. H.A. Armstrong and M.D. Brasier 2005 Microfossils. Blackwell Publishing
7. P.K. Kathal. 2012. Applied Geological Micropalaeontology. Scientific Publishers
8. P.K. Saraswati & M.S. Srinivasan 2016 Micropaleontology. Springer
9. S. Jain. Microfossils. 2020. Springer
10. Gross, M.G.1972 Oceanography - A view of the Earth. Prentice-Hall.
11. S. Davis, R.A. Jr. 1972 Principles of Oeanography. Addison -Wesley Publishing Company.
12. Bhatt, J.J. 1978 Oceanography - Exploring "the planet Ocean. D. van Nostrand Company.
13. Haq, B.U. & Milliman, J.D. 1984 Marine Geology and oceanography of Arabian Sea and coastal Pakistan. Elite Publishers Limited.
14. Roonwal, G.S. 1986 The Indian Ocean: Exploitable mineral & petroleum Resources. Narosa Publishing house
15. Duxbury, A.B. & Duxbury, A.C. 1993 Fundamentals of Oceanography. Wm. C. Brown Publishers.
16. Qasim, S.Z. &Roonwal, G.S. (eds) 1996 India's Exclusive Economic Zone. Omega Scientific Publishers.
17. Garrison, T. 1995 Oceanography- An invitation to Marine Science. Wadsworth Publishing Company.
18. A.P. Trujillo & H.V. Thurman 2012 Essentials of Oceanography. PHI Learning Private Limited
19. Garrison, T. & Ellis, R. 2016 Oceanography: An invitation to Marine Science, National Geographic Learning.
20. Savindra Singh. 2021. Oceanography. Indigo Books.

Course No.: P2AGTC302 **Title: Ore Geology**
Credits: 04 **Maximum Marks: 100**
Duration of Examination:3hrs **(Minor I-20, Minor II 20, Major 60)**

(Syllabus for the examination to be held in Dec. 2026, Dec. 2027 & Dec. 2028)

Course Objectives: The course deals with thenatural mineral resources and their association with different host rocks during their formation. The main objective of the course is to impart knowledge and understanding about the fundamental and advanced concepts regarding the origin of various ores and industrial minerals. To provide thorough knowledge on the mineral assemblages, textural features, paragenetic order and metallogeny and to understand the formation, mode of occurrences and types of various petrological ore associations.

Course Outcomes: Upon completion of the course, students will be able to:

- Understand the different ore systematic at divergence geological setting and terrains with implications for exploration.
- Identification of minerals based on their optical properties and textural behaviour and their application in mineral beneficiation industries.
- To know the source and depositional environment based on isotopic and fluid inclusion studies.
- To apply the knowledge in exploration of the mineral resources
- To understand the use of minerals in Industry

UNIT-I:Ore Geology Techniques

1.1 Introduction to ore mineralogy and ore microscopy
1.2 Qualitative and Quantitative methods in the identification of Ore minerals.
1.3 Introduction to ore textures, microstrutures and applications: Ore textures and paragenesis. Industrial application of ore microscopy
1.4 Fluid Inclusion studies.

UNIT-II:Othomagmatic Ore Deposits associated Mafic and Ultramafic rocks

2.1 Chromite deposit associated with mafic and ultramafic rocks: their types and genetic models.
2.2 Genesis of Cu-Ni ± Co sulphides deposits associated with magmatic processes.

2.3 Diamond deposits associated with Kimberlites their characteristics and genetic models.
2.4 REE-Nb-Industrial minerals (± Cu) mineralization associated with Carbonatites- their characteristics and genesis.

UNIT-III: Late Magmatic Deposits associated with Felsic rocks
3.1 Granite-related mineralization systems: diversity of mineralization styles and relatedmineral deposits.
3.2 Porphyry copper deposits- types, characteristics, associated alterations and origin.
3.3 Intrusion-related gold systems
3.4 Pegmatites and associated mineralization.

UNIT IV: Hydrothermal System
4.1 Components of hydrothermal system, Geodynamics and Temporal Evolution of Hydrothermal Mineral Systems
4.2 Hydrothermal Processes and Wall Rock Alteration.
4.3 Intrusion related Hydrothermal system, mineralisation associated with greisens and skarns
4.4 Submarine hydrothermal system: Volcanic hosted massive sulfide deposits – types, characteristics and mode of occurrences

Unit V Ore Deposits associated with Sedimentary and weathering processes
5.1 Placers and paleoplacers – process and mechanism of development, tectonic and temporal aspects of placer deposition and origin of ores
5.2 Sedimentary and synsedimentary iron ore deposits – types, general characteristics and origin..
5.3 Stratabound carbonate hosted base metal deposits – types, general characteristics and genetic models.
5.4 Ores related to weathering processes – bauxite, laterite and Ni/Au-laterite deposits, general characteristics and process of formation. Supergene enrichment.

Books Recommended

1. Craig, J.R and Vaughan, D.J., 1981. Ore Microscopy and Ore petrography. John Wiley&sons
2. Kula C Misra. 2001. Understanding Mineral Deposits. Kluwer Publ.
3. Robb, L. (2005) Introduction to Ore-Forming Processes by, Blackwell Publishing Ltd.
4. H.L.Barnes (Ed). 1997. Geochemistry of Hydrothermal deposits. III Edn. John Wiley & Sons.
5. A.M. Evans. 1997: Ore Geology and Industrial minerals- An introduction (III edn.) Geoscience, Texas
6. Mukerjee A Ore Genesis: A Hollastic Approach
7. Robb, L J Introduction to Ore Forming Processes
8. Pirajno Franko Hydrothermal Mineral Deposits
9. Sharma,R&Srivastava,PK Hydothermal Fluids of Magmatic origin in S Kumar and R N Singh Modelling of Magmatic and allied processes, Springer
10. Srivastava, P K On e-pathshala on website of UGC, New Delhi

Course No.: P2AGTC303 **Title: Sedimentary Basin Analysis & Hydrocarbon Resources**
Credits: 04 **Maximum Marks: 100**
Duration of Examination: 3 hours **(Minor I-20, Minor II 20, Major 60)**

(Syllabus for the examination to be held in Dec. 2026, Dec. 2027 & Dec. 2028)

Course Objectives: This course is about deciphering the earth's history from the pages of the earth's past written in the sedimentary rocks. The course shall help students to understand the evolution and depositional mechanism of different sedimentary basins in relation to endogenic and exogenic controls.

Course Outcome: Sedimentary Basin Analysis course shall reflect the advanced understanding and analytical capabilities expected at the postgraduate level with critical thinking, technical proficiency and research skills. The students shall be able to analyze the tectonic settings and geodynamic evolution of some important sedimentary basins in India. This course shall help the students to interpret sedimentary facies, depositional environments, and sequence stratigraphy for basin classification and resource evaluation. In addition, the students shall learn to integrate geological, geophysical, and geochemical data for resource assessment in sedimentary basins.

UNIT-I Basins and their evolution

1.1 Mechanisms of basin formation; Continental and marine sedimentary basins, Allogenic controls on basin evolution

1.2 Tectonic classification of sedimentary basins – intra-plate basins (pre-rift); divergent-margin basins (syn-rift); intra-plate basins (post-rift); convergent-margin basins; collision and post-collision basins; strike-slip basins.

1.3 Tectonic evolution of Siwalik basin as an example of collision tectonics

1.4 Tectonic evolution of Kutchchh basin as an example of extensional tectonics

UNIT-II Basin Analysis

2.1 Methods of basin analysis (Tectonic, stratigraphic and sedimentological)

2.2 Tools of basin analysis– Facies analysis, sediment dispersal and palaeo-flow analysis

2.3 Geophysical tools (seismic, gravity), Geochemical tools (organic and mineral geochemistry)

2.4 Application of carbon and oxygen isotopes in sedimentology

UNIT-III Depositional Environments

3.1 Classification of sedimentary environments

3.2 Continental sedimentary environments (Fluvial, Lacustrine)

3.3 Shallow marine sedimentary environments (Estuary, Delta, Tidal flat, Lagoon)

3.4 Deep marine sedimentary environment (Submarine fan, Abyssal plain)

UNIT-IV Sequence Stratigraphy

4.1 Concept of sequence stratigraphy, Sea level changes, aggradation, progradation, retrogradation, transgression and regression; Eustatic sea level changes

4.2 System tracts - lowstand system tract, transgressive system tract, transgressive surface and highstand system tract

4.3 Sequences, parasequences; Flooding surface, maximum flooding surface, marine flooding surface; overlap, offlap, toplap and onlap

4.4 Sequence stratigraphic approach in basin analysis and case history of important petroliferous basins of India.

UNIT-V Hydrocarbon Basins

5.1 Origin of Petroleum (Inorganic and Organic theories). Generation, maturation process, migration and accumulation of oil and gas, oil shales

5.2 Concept of petroleum system: Reservoir rocks (clastic and non-clastic reservoir rocks, development and types of porosity in these rocks. Controls of permeability).

5.3 Petroleum traps: Cap rocks (seals), Occurrence, surface indications and direct detection of hydrocarbons.

5.4 Petroliferous basins of India (Assam, Bombay High, Ankleshwar)

Books Recommended

1. Miall, Andrew D. — Principles of Sedimentary Basin Analysis
2. Miall, A D. — Fluvial Depositional System
3. Lindholm, R. C. — A Practical Approach to Sedimentology
4. Reineck, H. E. & Singh, I. B. — Depositional Sedimentary Environments
5. Reading, H.G. — Sedimentary Environments
6. Selley, R.C. — Applied Sedimentology
7. Bjorlykke, K. — Sedimentology and Petroleum Geology
8. Leeder, M.R. Sedimentology: — Process and Product
9. Prothero and Schwab — Sedimentary Geology
10. Swift, Oertal, Tillman and Thorne — Shelf Sand and Sandstone Bodies:
11. Zutshi and Panwar — Geology of Petroliferous Basins of India
12. Bhandari et al. — Petroliferous Basins of India
13. Miall, A D — The Geology of Sequence Stratigraphy
14. Catuneanu O — Principles of Sequence Stratigraphy
15. Gary Nichols — Sedimentology and Stratigraphy
16. Stephen Killops and Vanessa Killops — Introduction to Organic Geochemistry
17. Sam Boggs, Jr. — Principles of Sedimentology and Stratigraphy
18. Barker, C. — Thermal Modeling of Petroleum Generation
19. Holson, G.D. and Tiratso, E.N. — Introduction of Petroleum Geology
20. Hunt, J.M. — Petroleum geochemistry and geology
21. Jahn, F., Cook, M. and Graham, M. — Hydrocarbon Exploration and Production
22. North, F.K. — Petroleum Geology,
23. Selley, R.C. — Elements of petroleum geology,
24. Tissot, B.P. and Welte, D.H. — Petroleum formation and occurrence

Course Code: P2AGTC304
Course Credit: 4
Duration of Examination: 3 hours

Course Title:Geotechnical Engineering
Marks: 100
(Minor I-20, Minor II 20, Major 60)

(Syllabus for the examination to be held in Dec. 2026, Dec. 2027 & Dec. 2028)

Course Objectives: This advance course in geotechnical engineering aims to provide students with a comprehensive understanding of soil and rock mechanics fundamentals, including their formation, classification, and engineering properties. The objective is to equip students with the knowledge and skills necessary to analyze the stress-strain behavior and shear strength of soils, understand rock mass characterization and classification systems. Furthermore, the course seeks to introduce the principles of rock mechanics, covering intact rock properties, the influence of discontinuities in rock masses, and various rock mass classification systems like RQD, RMR, Q-system, and SMR. A significant objective is also to equip students with knowledge for analyzing and addressing geotechnical challenges in engineering projects.

Course Outcomes: Upon completion of this course

- Students will be able to classify and characterize various soil types based on their physical and index properties
- They will be able to analyze the stress-strain behavior of soils
- Students will be capable in understanding and applying various shear strength theories and laboratory/field tests for soils.
- Understand the significance of discontinuities, and apply different rock mass classification systems to assess rock quality for engineering applications in various geotechnical engineering projects such as dams, highways, tunnels, and bridges.

Unit 1: Fundamentals of Soil Mechanics

1.1- Introduction and scope of geotechnical engineering; Types of geotechnical investigations associated with dams, highways, tunnels and bridges.

1.2- Concept of soil mechanics; Phase relationships of soils: water content, specific gravity, absorption value, degree of saturation, void ratio, porosity, unit weights.

1.3- Index Properties of Soil - Atterberg's limits (Liquid Limit, Plastic Limit, and Shrinkage Limit) and their significance; Particle size distribution (sieve analysis, hydrometer analysis); Soil compaction: principles and methods (Proctor test).

1.4- Concept of Permeability & Seepage; coefficient of permeability; factors affecting permeability; laboratory and field permeability tests, significance of the permeability & seepage test.

Unit 2: Stress-Strain Behavior of Soils and Shear Strength

2.1- Concepts of stress, strain, and elastic moduli; total stress, pore water pressure, and effective stress; importance of effective stress in geotechnical analysis.

2.2- Concept of Mohr-Coulomb failure criterion; parameters of shear strength: cohesion (c) and angle of internal friction (phi), factors affecting shear strength (draining conditions, stress history).

2.3- Laboratory Shear Strength Tests: Direct Shear Test, Triaxial Compression Test, Vane Shear Test; their advantages, and limitations.

2.4- Field Shear Strength Tests: Standard Penetration Test (SPT), Cone Penetration Test (CPT), their correlation with soil properties and its applications.

Unit 3: Rock Mechanics Fundamentals & Rock Mass Characterization

3.1- Introduction to Rock Mechanics: Rock as an engineering material; Selection criteria of rock masses for various purposes; Differences between intact rock and rock mass properties.

3.2- Intact Rock Properties: Physical properties: density, porosity, water absorption, Mechanical properties: Uniaxial Compressive Strength (UCS), Tensile Strength, Modulus of Elasticity, Poisson's Ratio.

3.3- Discontinuities in Rock Masses: Joints: Formation, types, and geological significance; Geometric parameters of discontinuities/joints: orientation (strike, dip, dip direction), spacing, persistence, roughness, infilling, weathering condition.

3.4- Concept and scope of kinematic analysis of rock slopes for knowing various modes of failures; Conditions of planar failure, wedge failure and toppling failures.

Unit 4: Rock Mass Classification Systems & Applications

4.1- Introduction to Rock Mass Classification: Rock Quality Designation (RQD): Limitations and applications of RQD in rock mass quality assessment.

4.2- Concept of Rock Mass Rating (RMR) System: Parameters of RMR (UCS, RQD, spacing of joints, condition of joints, groundwater, and orientation of joints); Calculation of RMR_{basic}; Applications of RMR in tunneling and slope stability.

4.3- Introduction to tunneling index (Q-System); parameters of Q-system: rock quality assessment, joint roughness number (Jr), joint set number (Jn), joint alteration number (Ja), joint water reduction (Jw), stress reduction factor (SRF); Calculation and interpretation of Q-value; Applications of Q-system, tunnel supports.

4.4- Introduction to Slope Mass Rating (SMR) System; Extension of RMR for slope stability analysis; Parameters of SMR and its modifications; Application of SMR in evaluating rock slope stability.

Unit 5: Landslides and Slope Stability

5.1- Landslides: nomenclature; significance and global impact of landslides, classifications (Varnes, 1978; Van Schalkwyk and Thomas, 1991; Cruđen and Varnes, 1996)

5.2- Factors triggering landslides: role of geological, hydrological and anthropogenic factors; failure mechanism; Concept of the factor of safety in slope stability

5.3- Concept of landslide susceptibility mapping: Heuristic (Qualitative) Methods, Statistical Methods; Machine Learning techniques, Deterministic (Physical-Based) Models and Hybrid Methods.

5.4- Landslide mitigation measures: slope modification, drainage improvement, retaining structures, rock fall protection, slope reinforcement practices; Role of public awareness and education in reducing landslides; early warning systems

Recommended Books:

1. Principles of Geotechnical Engineering by Braja M. Das (2017)
2. Soil Mechanics in Engineering Practice by Terzaghi, Peck &Mesri (1996)
3. Soil Mechanics and Foundations by B.C. Punmia (2017)
4. Soil Mechanics by T. William Lambe & Robert V. Whitman (1969)
5. Fundamentals of Soil Behavior by James K. Mitchell (2005)
6. Soil Testing for Engineers by T.W. Lambe (1951)
7. Field Testing and Instrumentation of Soils by P. Mohan Das (2009)
8. Introduction to Rock Mechanics by Richard E. Goodman (1989)
9. Rock Mechanics for Underground Mining by B.H.G. Brady & E.T. Brown (2004)
10. Engineering Geology by F.G. Bell (2007)
11. Practical Rock Engineering by Evert Hoek (2007)
12. Engineering Rock Mass Classifications by Z.T. Bieniawski (1989)
13. Rock Slope Engineering by Wyllie & Mah (2004)
14. Geotechnical Engineering Investigation Manual by Roy E. Hunt (2005)
15. Landslide Hazard and Risk edited by Glade, Anderson, and Crozier (2005)
16. Stabilization of Earth Slopes and Landslides by Donald H. Gray (2012)
17. Principles of Engineering Geology by Prabin Singh
18. A textbook of General and Engineering Geology by D. S. Arora.

Course No.: P2AGTC305 **Title: Application of Remote Sensing & GIS in Geology**
Credits: 02 **Maximum Marks: 50**
Duration of Examination: 2½ hours **(Minor I-10, Minor-II 10, Major -30)**

(Syllabus for the examination to be held in Dec 2026, Dec 2027&Dec 2028)

Course Objectives:Role of Remote Sensing & GIS technology in geology, geomorphology, lithology interpretation and resultant landforms.Geospatial applications in watershed management, Mineral & oil Exploration and disaster management

Course Outcomes: On successful completion of the course the students will be able-

- To understand the concepts of remote sensing applications in the geology
- To examine the spectral characteristics of rocks and minerals.
- To understand drainage patterns, Lithology and structural interpretation of folds, faults, fluvial, glacial & karst landforms.
- To analysis the DEM for Terrain Evaluation, structural and denudational landforms.
- Remote sensing & GIS application in Watershed management, mineral exploration, oil exploration, geological hazards mapping and disaster management.

Unit-1

1.1 Remote Sensing in geology – an overview
1.2 Basic concept of geomorphology, earth surface process and resultant landforms
1.3 Spectral characteristics of rocks and minerals
1.4 Interpretation of drainage patterns – types and its significance in geologic interpretation

Unit -2

2.1 Lithological interpretation: Igneous rocks, Sedimentary rocks and MetamorphicnRocks; lithological mapping
2.2 Structural interpretation: folds, faults unconformities and lineaments; structural mapping
2.3 Interpretation of fluvial landforms
2.4 Interpretation of glacial and Karst landforms

Unit – 3

3.1 Digital Elevation Model, terrain evaluation and geomorphological mapping
3.2 Interpretation of structural and denudational landforms – cuesta, hogback, butte, mesa, etc
3.3 Interpretation of landforms related to igneous, sedimentary and metamorphic rocks
3.4 Morphometric analysis and its applications in morphotectonics

Unit – 4

4.1 Remote Sensing in water exploration; Role of Remote Sensing in watershed conservation, planning and management
4.2 Remote sensing in mineral exploration - an overview and application of remote sensing in mineral exploration - Indian examples
4.3 Remote sensing in oil exploration - features helpful in detection of target areas for oil exploration
4.4 Geological hazards mapping and disaster management

Books Recommended

Drury, S.A., 1987 — Image Interpretation in Geology. Allen and Unwin
Gupta, R.P.., 1990 — Remote Sensing Geology. Springer Verlag.
Jensen, J.R. 2000 — Remote Sensing of the Environment: An Earth resource Perspective. Prentice Hall
Lillesand, T.M., and Kieffer, R.M., 1987 — Remote Sensing and Image Interpretation, John Wiley.
Paine, D.P., 1981: — Aerial Photography and Image Interpretation for Resource Management. John Wiley.
Pandey, S.N., 1987: — Principles and Applications of Photogeology. Wiley Eastern.
Miller, V.C., 1961: — Photogeology. McGraw Hill.
Ray, R.G., 1969: — Aerial Photographs in geologic Interpretations. USGS Prof, Paper 373.

Course No.: P2AGTC306 **Title: Practicals related to 301, 302, 303, 304, 305**
Credits: 04
Maximum Marks: 100 **Duration of Examination: 4 hours**

P2AGPC301 Palaeocurrent analysis: Tilt correction, calculation of azimuthal direction; Preparation and interpretation of lithologs and isopach maps; Analysis of seismic profiles; Delineation of sequence boundaries, systems tracts and parasequences in sedimentary sequences

P2AGPC302 Processing of samples, picking and mounting of microfauna, study of diagnostic morphological characters of selected microfossils, construction of biostratigraphic charts, ocean floor profiles, bathymetry of oceanic sub-environments, circulation patterns etc.

P2AGPC303 Petrography of clastic and non-clastic rocks; Palaeo-current analysis: Tilt correction, calculation of azimuthal direction; Preparation and interpretation of lithologs and isopach maps; Analysis of seismic profiles; Delineation of sequence boundaries, systems tracts and parasequences in sedimentary sequences

P2AGPC304 Kinematic analysis of joint data, determination and interpretation of various rock mass classification systems, including RQD (Rock Quality Designation), RMR_b (Rock Mass Rating Basic), Slope Mass Rating (SMR) and Tunneling Index (Q-system); determination of Atterberg limits and Uniaxial Compressive Strength (UCS) test of rocks.

P2AGPC305 Visual interpretation of satellite images to study the Geomorphology, lithology, geology and structure; Digital image processing for the study of geomorphology, structure, and lineaments; Geomorphic mapping; Lineament mapping; Structural mapping; Preparation of Hydro-geomorphology map.

Course No P2AGPC307 **Geological Field Work(Outstation 10-15 days)**
Credits: 2 **Max. Marks: 50**

This course shall comprise of 10-15 day's field work in areas of geological interest, preferably out of state. The students shall have experiential learning on map reading, rock and mineral identification, geological mapping in structurally complexed terrain/ mineralised area / Industrial training/ visit to mining areas etc. Practical skills such as field mapping, understanding the relationships between different rock types and their formation processes, sample collection, data recording, data interpretations and report writing are also emphasized. At the end the students shall submit a comprehensive field report. The distribution of marks shall be as follows:

Attendance: 10%
Performance during the fieldwork: 20%
Field Report: 60%
Viva-voce at the time of external examination: 10%

SEMESTER - IV

Course No.: P2AGTC401 | **Title: Quaternary Geology and Palaeoclimate**
Credits: 04 | **Maximum Marks: 100**
Duration of Examination: 3 hours | **(Minor I-20, Minor II 20, Major 60)**

(Syllabus for the examination to be held in May 2027, May 2028 & May 2029)

Course Objectives: This course is designed for postgraduate students in Geology, aiming to provide both theoretical and practical understanding of Earth's recent geological past and its climate history. The students shall study the fundamental aspects of Geology that help in understanding and reconstruction of palaeoclimate and active tectonics during the Quaternary time period.

Course Outcomes: This course shall help the students to

- Understand the processes that have resulted into the climate change and tectonic deformation during the Quaternary time period.
- Understand the role of different environmental and geological proxies to reconstruct past climate changes
- Equip the students with skills in analytical methods used in Quaternary geology research

Unit I: Fundamentals of Quaternary Period and Climate Change

1.1. Pleistocene and Holocene: Definition, chronology, subdivisions and duration.
1.2. Earth's climate system: The causes and timescale of climatic variations, solar forcing and earth's orbital parameters.
1.3. Tectonic scale climate change: Plate tectonics and long-term climate change, CO2 and long-term climate change,
1.4. Major Global Quaternary Events: Ice ages, Younger Dryas, Holocene Climate Optimum

Unit II: Palaeoclimate Proxies and Reconstruction

2.1. Palaeoclimate proxies: Ice cores, tree rings, speleothems, marine and lake sediments.
2.2. Stable isotopes ($\delta^{18}O$, $\delta^{13}C$), biomarkers, and geochemical indicators of palaeoclimate.
2.3. Palaeotemperature and palaeo-precipitation reconstruction.
2.4. Palaeoenvironmental archives in India (Himalaya, Peninsular lakes, Ganga plains)

Unit-III: Tectonic Geomorphology

3.1. Tectonic Geomorphology: Geomorphic markers, Planer and Linear markers.
3.2. Geomorphic Indices of Active Tectonics: Hypsometric Curve and Hypsometric Integral Drainage Basin Asymmetry, Stream Length-Gradient Index (SL) and Mountain-Front Sinuosity.
3.3. Drainage Pattern and Structural control over the rivers in different tectonic environment.
3.4. Tectonic Geomorphology and faulting: Landforms in compressional, extensional, and strike-slip regime.

Unit-IV: Active Tectonics and Geodesy

4.1. Active Faults, geomorphic and geological signatures of active faults.
4.2. Displacement variations along an active fault, fault growth, and fault segmentation.
4.2. Surface rupturing and buried faults in different tectonic settings.
4.3. Geodesy: Fundamentals of geodesy, crustal deformation across fault zones, interseismic strain accumulation.

Unit-V: Palaeoseismology

5.1. Introduction to Palaeoseismology, relationship with other neotectonic studies.
5.2. Classification of Paleoseismic Evidence: Primary and secondary evidence of prehistoric earthquakes.
5.3. Field techniques in paleoseismology: Mapping paleoseismic landforms, locating sub-surface deformation, GPR survey, trenching and logging.
5.4. Prehistoric earthquake dating and recurrence, dating techniques, precision and their relation to recurrence.

Recommended Books

1. Bowen, D.Q. (1999). A Colour Atlas of Glacial Indicators. CRC Press.
2. Lowe, J.J. & Walker, M.J.C. (2014). Reconstructing Quaternary Environments. Routledge.
3. Ruddiman, W.F. (2008). Earth's Climate: Past and Future. W\.H. Freeman.
4. Roberts, N. (2013). The Holocene: An Environmental History. Wiley-Blackwell.
5. Bradley, R.S. (2014). Paleoclimatology: Reconstructing Climates of the Quaternary. Academic Press.
6. Burbank, Douglas West_ Anderson, Robert Stewart - Tectonic Geomorphology (2012, Wiley-Blackwell_J. Wiley & Sons) - libgen.lc
7. Goudie, A. (2004). The Human Impact on the Natural Environment. Wiley-

8. Edward A. Keller - Blackwell.
Active TectonicsEarthquakes, Uplift, and Landscape-Prentice Hall College Div (1995).

Course No.: P2AGTC402 **Title:Natural Hazards and Disaster Management**
Credits: 02 **Maximum Marks: 50**
Duration of Examination: 2½ hours **(Minor I-10, Minor-II 10, Major -30)**

(Syllabus for the examination to be held in May 2027, May 2028 & May 2029)

Course Objectives: This course aims to provide students with the essential knowledge and skills needed for hazards and disaster management. The primary objective is to enable students to understand the types, causes, and consequences of various hazards, both natural and human-induced. Students will learn to assess vulnerability and risk, comprehend different disaster management strategies, and analyze the crucial roles of institutions and stakeholders in this field. The course seeks to foster critical thinking, preparing students for effective disaster preparedness, response, recovery, and long-term resilience building.

Course Outcomes: Upon completing this course, students will be able to

- Effectively analyze vulnerability and its implications on disaster risk.
- Capable of applying the disaster management cycle to real-world scenarios and will possess a clear understanding of the institutional frameworks and emerging trends in disaster management
- Able to recognize the vital roles of various stakeholders in disaster risk governance, contributing to the country's capacity-building efforts toward a more disaster-resilient society

Unit 1: Fundamentals of Hazards and Risk

1.1- Introduction to Hazards: Definition and classification of hazards, distinguish between natural and anthropogenic hazards, causes and consequences.
1.2- Introduction to Disaster Risk: Core concept of disaster risk, key components of disaster risk, interrelationship between hazards, vulnerability, and capacity
1.3- Understanding Vulnerability: Various forms of vulnerability- physical, social, economic, and environmental vulnerability; role and contribution of vulnerability to amplify disaster risk.
1.4- Overview of major geohazards: Comprehensive look at the mechanisms, impacts, initial mitigation strategies.

Unit 2: Key Hazards and Disaster Management Cycle

2.1- Cyclones, Wildfires and Droughts: characteristics, causes, preventive measures and socio-economic consequences of specific hazards.
2.2- Core Concepts of Disaster Management (DM): Definition and scope of disaster management, its key components, distinction between Crisis Management and Risk Management.
2.3- Disaster Management Cycle: Pre-disaster stages (prevention, mitigation, preparedness); Syn-disaster stage-emergency stage (response); post-disaster stages (rehabilitation, reconstruction, recovery).
2.4- Impact of Disaster on Development: Analysis of how disasters impact development; paradigm shift in disaster management.

Unit 3: Policy Frameworks for Disaster Risk Reduction

3.1- Approaches to Disaster Risk Reduction (DRR): Comprehensive study of prevention, mitigation, and preparedness strategies as fundamental components of disaster risk reduction.
3.2- India's National DM Policy: Overview of India's national policy on disaster management;
3.3- Evolution and key features of India's DM policy; legal framework; Disaster Management Act, 2005.
3.4- National Disaster Management Framework (India): Structure and functions of key national, state, and district-level authorities in India (NDMA, NEC, SDMA, DDMA).

Unit 4: Stakeholders and Future of Disaster Management

4.1- Disaster Profile of India: Analysis of major disasters in India, including their regional and seasonal profiles, and lessons learned from past events.
4.2- Stakeholder Roles and Responsibilities: Roles of specialized institutions like NIDM and NDRF and SDRF, armed/paramilitary forces.
4.3- Roles of urban and local bodies, social networking, print and electronic media, NGOs, and local communities.
4.4- Global Challenges and Opportunities: Overview of global challenges in disaster management and emerging opportunities for innovation and collaboration.

Recommended Books:

1. Confronting Catastrophe: New Perspectives on Natural Disasters- Alexander, D. (2000).
2. Natural Hazards and Disasters- Donald Hyndman & David Hyndman (5th Edition, 2016)
3. At Risk: Natural Hazards, People's Vulnerability and Disasters- Piers Blaikie, Terry Cannon, Ian Davis, Ben Wisner (2nd Edition, 2004)
4. Introduction to Geomorphology and Natural Hazards- K.S. Valdiya (Universities Press, 2010)
5. Disaster Management: Future Challenges and Opportunities- R.B. Singh (Springer, 2014)
6. Disaster Management- S.C. Sharma (Khanna Publishing, 2019)
7. Introduction to International Disaster Management- Damon P. Coppola (Butterworth-Heinemann, 3rd Edition, 2015)
8. Disasters and Development- Cuny, Frederick C. (Oxford University Press, 1983)
9. Handbook of Disaster Risk Reduction and Management (Ben Wisner, JC Gaillard, Ilan Kelman (Routledge, 2021)
10. Disaster Management in India (Ministry of Home Affairs, Government of India, 2011)
11. The Sendai Framework for Disaster Risk Reduction 2015–2030: A Critical Appraisal- Rajib Shaw (Springer, 2016)
12. Role of Institutions in Disaster Risk Reduction and Management (NIDM, Government of India)
13. India Disaster Report: Towards a Policy Initiative- Parasuraman & Unnikrishnan (Oxford University Press, 2000)
14. Community-Based Disaster Risk Reduction- Rajib Shaw (Emerald Publishing, 2012)
15. Disaster Risk Governance in India and Cross Cutting Issues- Indrajit Pal, Rajib Shaw (Springer, 2017)
16. Disaster Risk Reduction for the Built Environment- Lee Bosher (Wiley-Blackwell, 2014)

Course No.: P2AGTE403 | **Title: Gemology**
Credits: 02 | **Maximum Marks: 50**
Duration of Examination: 2½ hours | **(Minor I-10, Minor II 10, Major 30)**

(Syllabus for the examination to be held in May 2027, May 2028 & May 2029)

Course Objectives: To introduce the students about the concepts and techniques for identification of gemstones

UNIT - I Basics of Gemology

1.1 Gem and gemstones; General characteristics and chemical composition of gemstones; Nature of gem material: quality necessary in gems-beauty, rarity, durability.
1.2 Formation of gem stones. Crystal form and habit.
1.3 Nature of crystals: distinction between crystalline and amorphous material, crystal symmetry, Twinning, parallel growth, crystal form, crystal habit, seven crystal system. Identification of rough stones.
1.4 Classification of gem stones

UNIT - II Physical Characteristics of Gemstones

2.1 Physical characteristics of gemstones; Cleavage, Fracture, parting, and their importance in gemology and lapidary work. Units of measurement: metric scale, carat, pearl and grain.
2.2 Colours in gemstone: causes
2.3 Hardness its applications in gemology and limitations.
2.4 Quantitative determination of Specific gravity of gemstones by hydrostatic weighing, heavy liquids, flotation and pycnometer. Inclusions and other features of gemstones

UNIT - III Optical Characteristics of Gemstones

3.1 Electromagnetic spectrum, reflection and its importance in gemology, lustre, aventurescence, sheen, chatoyancy, asterism, luminescence, play of colours, labradorescenceetc.
3.2 Principal, Construction and use of refractometer in gemology
3.3 Polariscope and Dichroscope: construction and use in gemology,
3.4 Application of Chelsea colour filter, Infra-red ultraviolet and x-rays in gem identification

UNIT - IV Advance Gemology

4.1 Synthetic gemstones, methods of synthesis, and its characteristics. differentiation between natural and synthetic stones
4.2 Gem enhancement methods and their identification: colourless/coloured impregnation, heat treatment, coating, irradiation, diffusion, treatment, etc.
4.3 Imitation gemstones, glass and plastic imitations; organic materials. Pearls, corals, ivory and shells and amber and others

4.4 Grading of diamonds and coloured gemstones

Recommended Books:

1. Brocardo, G. (1981) Minerals and Gemstones – An identification Guide
2. Bruton Eric F.G.A. (1970) Diamonds
3. Karanth, R. V (, 2000). Gems and Gem Industry, Geological Society of India, Memoir, 45
4. Max Bauer (1968) Precious stones, Vol. I and II
5. Orlov Yu L (1973) The Mineralogy of the Diamond
6. Rajendran S. (2007): Mineral Exploration: Recent Strategies
7. Wilson, M. (1967) Gems

Course Code: P2AGTE404 **Course Title: Glaciology**
Course Credit: 2 **Marks: 50**
Duration of Examination: 2½ hours **(Minor I-10, Minor II 10, Major 30)**

(Syllabus for the examination to be held in May 2027, May 2028 & May 2029)

Course Objectives: This course aims to give students an extensive understanding of the processes involving ice, snow, and glaciers in the Earth's cryosphere. It seeks to educate students on the dynamics, development, and interactions of glaciers with climate systems. The importance of glaciers in hydrology is emphasized in the course, particularly as it relates to the Himalayan region and the management of water resources. Students will gain knowledge on how to use technology and field-based methods to examine glacial processes and features. The effects of climate change on glaciers and related hazards like GLOFs are also emphasized.

Course Outcome: Upon successful completion of the course students will be

- Understanding of the dynamics, formation, and melting processes of glacier
- Able to evaluate the environmental effects of glacier-climate interaction
- Comprehend how glaciers, specifically in the Himalayan environment, play a hydrological function in managing water resources
- Prepared to assess the environmental and social effects of glacier retreat and related risks like floods caused by glacial lake outbursts

Unit 1: Introduction to Glaciology and Fundamental Concepts

1.1 Definition and Scope of Glaciology: Importance in Earth sciences and applications in climate and environmental studies

1.2 Types and Distribution of Glaciers: Alpine, continental, and other glacier types; Global glacier distribution and major ice sheets

1.3 Glacier Formation and Mass Balance: Snow accumulation and transformation into glacial ice; Mass balance concepts and equations

1.4 Glacier Geometry and Classification: Glacier morphology (cirques, valley glaciers, ice caps); Classification based on thermal regime (temperate, polar)

Unit 2: Glacier Dynamics and Movement

2.1 - Mechanisms of Glacier Motion: Internal deformation, basal sliding, and subglacial bed deformation

2.2 - Glacier Flow Laws and Models: Glen's flow law, creep, and stress-strain relationships

2.3 - Ice Rheology and Deformation: Crystal structure of ice; Temperature and impurity effects on flow

2.4 - Velocity Measurement and Flow Patterns: GPS, remote sensing, and field methods; Longitudinal and transverse velocity profiles

Unit 3: Glacier Hydrology and Thermal Regime

3.1 Glacial Meltwater and Drainage Systems: Supraglacial, englacial, and subglacial drainage networks

3.2 Heat Transfer in Glaciers, Temperature Profiles and Thermal Zonation: Conduction, convection, and latent heat; Cold vs warm-based glaciers; Seasonal variations in glacier temperature

3.3 Glacial Surges and Thermal Feedbacks: Mechanisms and case studies of glacial surging; Role of thermal conditions in glacier instability

3.4 Glacial Lakes and GLOFs (Glacial Lake Outburst Floods): Formation and types of glacial lakes; Triggering mechanism

Unit 4: Glacial Landforms and Climate Change

4.1 Erosional and Depositional Landforms of glaciers; Glacial Sediments and Transport Mechanisms: Till, glaciofluvial and glaciolacustrine deposits; Modes of sediment transport: supraglacial, englacial, subglacial

4.2 Periglacial Processes and Features: Permafrost, patterned ground, solifluction, etc.

4.3 Glaciers as Indicators of Climate Change: Ice core records, past climates, glacier response lags

4.4 Glacier Retreat and Hazards: Mass balance loss, rapid melting, rising GLOF risk; Concept of Monitoring and Modeling Glacier Changes.

Books recommended

1. Glaciers and Glaciation – Douglas I. Benn & David J.A. Evans (2nd Ed.)
2. The Physics of Glaciers – Kurt M. Cuffey & W.S.B. Paterson (4th Ed.)
3. Fundamentals of Glacier Dynamics – C.J. van der Veen
4. Introduction to Modern Glaciology – C.J. Fierz& A. Lüthi (Selected Chapters)
5. Ice Physics – Peter V. Hobbs
6. Remote Sensing of Glaciers – Petri Pellikka& W. Gareth Rees
7. Principles of Glacier Mechanics – Roger LeB. Hooke
8. Glacial Lake Outburst Floods (GLOFs): Causes, Impacts and Mitigation – Edited by R.B. Singh & D. Thakur (Springer),
9. Snow and Glacier Hydrology – Satya Singh (for Himalayan context)
10. Glacial Geology: Ice Sheets and Landforms – Matthew R. Bennett & Neil F. Glasser
11. Glacial Sedimentary Processes and Products – Edited by Michael J. Hambrey et al.
12. Periglacial Geomorphology – Hugh M. French.
13. The Cryosphere – Shawn J. Marshall (Part of the Princeton Primers in Climate series)
14. Climate Change and Glacial Hazards in the Indian Himalayas – R.K. Goyal (for case studies on GLOFs)
15. Sea Level Rise: History and Consequences – Bruce C. Douglas et al., Ice Sheets and Late Quaternary
16. Environmental Change – Martin J. Siegert
17. Glaciers: Climate, Hydrology and Geomorphology – Atle Nesje & Sveinn Brynjólfsson
18. Himalayan Glaciers: Hydrology and Hydrochemistr. D.P. Dobhal (Springer)
19. Glaciology and Glacial Geomorphology- Navodita Bhatnagar
20. Glacier Atlas of India- V.K. Raina and Deepak Srivastava

Course Code: P2AGTE405 **Course Title: Earthquake Geology**
Course Credit: 2 **Marks: 50**
Duration of Examination: 2½ hours **(Minor I-10, Minor II 10, Major 30)**

(Syllabus for the examination to be held in May 2027, May 2028 & May 2029)

Course Objectives: Earthquake Geology course aims to provide students with a complete knowledge and understanding of the geological processes and features associated with earthquakes. This course focuses on the mechanics of faulting, seismic cycles, and the identification of active tectonic structures. Students will learn to analyze surface expressions of seismic activity, such as fault ruptures and ground deformation. Through the application of techniques like paleoseismology, course equips students with the skills necessary for seismic hazard assessment and risk mitigation.

Course Outcomes: This course will help students to develop a comprehensive understanding of

- Geological processes underlying seismic activity
- Aanalyzing active fault systems, interpreting seismic records, and reconstructing the history of past earthquakesAssess seismic hazards and contribute to risk mitigation strategies through geological mapping and fault characterization.

Unit 1: Fundamentals of Earthquake Geology

1.1 Introduction to Earthquakes: Definition, causes, and classification of earthquakes; Historical earthquakes and their geological significance.

1.2 Introduction to Seismotectonic: Basics of plate tectonics and earthquake generation; Lithospheric deformation and stress accumulation.

1.3 Seismic Waves and Measurement: Types of seismic waves; instruments used for earthquake measurement, earthquake magnitude scales.

1.4 Stress and Strain in the Earth's Crust:Elastic rebound theory; Fault mechanics and rock deformation.

Unit 2: Fault Systems and Seismotectonics

2.1: Fault Types and Classification:Normal, reverse, strike-slip faults; Characteristics and behavior of active faults.

2.2 Seismic Cycle: Inter-seismic, co-seismic, and post-seismic phases; Fault segmentation and seismic hazard assessment.

2.3: Paleoseismology: Definition, goals, and significance; Field Techniques in Paleoseismology; Trenching, logging, and sampling methods.

2.4: Earthquake-Induced Landforms:Geomorphic markers, Surface ruptures, liquefaction, landslides; Case studies of earthquake-induced geomorphology.

Unit 3: Earthquake Hazards and Mitigation

3.1 Ground Shaking and Structural Damage: Effects of ground motion on infrastructure; Seismic building codes and retrofitting strategies.

3.2 Secondary Earthquake Hazards: Tsunamis, landslides, and soil liquefaction; Predictive models for secondary hazards.

3.3 Risk Assessment and Seismic Zoning: Mapping active seismic zones; Probabilistic hazard analysis.

3.4 Early Warning Systems and Preparedness: Earthquake forecasting methods; Emergency response strategies and community awareness.

Unit 4: Applications and advances in Earthquake Geology

4.1 Induced Seismicity and Anthropogenic Causes: Reservoirs, hydraulic fracturing, mining; Regulatory frameworks and monitoring.

4.2 Computational Seismology and Earthquake Simulation: Earthquake modeling and prediction algorithms; AI and machine learning applications in earthquake forecasting.

4.3 Case Studies of Significant Earthquakes: Analysis of notable earthquakes worldwide; Lessons learned from past seismic disasters.

4.4 Future Directions in Earthquake Research: Advances in earthquake geology and mitigation strategies; Role of interdisciplinary approaches in seismic studies.

Recommended Books:

1. Earthquake Geology. C. P. Rajendran, 2012 (latest edition)
2. Introduction to Seismology. Peter M. Shearer, 2009
3. An Introduction to Seismology, Earthquakes, and Earth Structure. Seth Stein and Michael Wysession, 2003 (2nd Edition)
4. Seismology and Plate Tectonics (Springer). R. K. Chadha, 2014
5. Seismic Waves and Sources. A. K. Ghosh, 1998
6. Earthquake Hazard and Seismic Risk Reduction. J. C. Paul and K. S. Valdiya, 2000
7. Seismology. D. S. K. Iyengar, 2001
8. Geology of Earthquakes. Robert S. Yeats, Kerry Sieh, and Clarence R. Allen, 1999
9. Plate Tectonics and Great Earthquakes. Lynn R. Sykes, 2019
10. Overview of Artificial Intelligence (AI) and Machine Learning (ML) in Seismology. Harendra Kumar Dadhich, 2023.

Course No.: P2AGRC406 **Title: Dissertation**
Credits: 16 **Maximum Marks: 400**

(Syllabus for the examination to be held in May 2027, May 2028 & May 2029)

The dissertation shall comprise field / laboratory work by a student. The allotment of specialization/ Supervisor shall be based on preference and merit (total marks obtained in Semester I & II).The number of students shall be distributed equally among the permanent faculty on the basis of merit and preference of students. The dissertation shall be evaluated by a board of Examiners comprising Head of the Department, Supervisor and an external examiner.