LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK (LOCF)

POSTGRADUATE PROGRAMME

MASTER OF SCIENCE (M. SC.) GEOLOGY

SEMESTER I /II – 2025-26

SEMESTER III/IV- 2026-27

SYLLABUS

SCHEME OF EXAMINATION AND COURSES OF STUDY

MAHARAJA GANGA SINGH UNIVERSITY BIKANER

Background

Considering the curricular reforms as instrumental for desired learning outcomes, all academic departments of Maharaja Ganga Singh University made a rigorous attempt to revise the curriculum of postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP". The Roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms.

The process of revamping the curriculum started with the series of webinars and discussions conducted by the University to orient the teachers about the key features of the Policy, enabling them to revise the curriculum in sync with the Policy. Proper orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to appreciate and incorporate the vital aspects of the Policy in the revised curriculum focusing on creating holistic, thoughtful, creative and well-rounded individuals equipped with the key 21st century skills 'for the development of an enlightened, socially conscious, knowledgeable, and skilled nation'.

With NEP-2020 in background, the revised curricula articulate the spirit of the Policy by emphasizing upon- integrated approach to learning; innovative pedagogies and assessment strategies; multidisciplinary and cross-disciplinary education; creative and critical thinking; ethical and Constitutional values through value-based courses; 21st century capabilities across the range of disciplines through life skills, entrepreneurial and professional skills; community and constructive public engagement; social, moral and environmental awareness; Organic Living and Global Citizenship Education (GCED); holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning; exposure to Indian knowledge system, cultural traditions and classical literature through relevant courses offering 'Knowledge of India'; fine blend of modern pedagogies with indigenous and traditional ways of learning; flexibility in course choices; student-centric participatory learning; imaginative and flexible curricular structures to enable creative combination of disciplines for study; offering multiple entry and exit points, alignment of Vocational courses with the International Standard Classification of Occupations maintained by the International Labour Organization; breaking the silos of disciplines; integration of extra-

curricular and curricular aspects; exploring internships with local industry, businesses, artists and crafts persons; closer collaborations between industry and higher education institutions for technical, vocational and science programmes; and formative assessment tools to be aligned with the learning outcomes, capabilities, and dispositions as specified for each course. The University has also developed consensus on adoption of Blended Learning with 10-20% component of online teaching and 80% face to face classes for each programme.

The revised curricula of various programmes could be devised with concerted efforts of the Faculty, Heads of the Departments and Deans of Schools of Study. The draft prepared by each department was discussed in series of discussion sessions conducted at Department, Faculty and the University level. The leadership of the University has been a driving force behind the entire exercise of developing the uniform template and structure for the revised curriculum. The Vice Chancellor of the University conducted series of meetings with Heads and Deans to deliberate upon the vital parameters of the revised curriculum to formulate a uniform template featuring Background, Programme Outcomes, Programme Specific Outcomes, Postgraduate Attributes, Structure of Masters Course, Learning Outcome Index, Semester-wise Courses and Credit Distribution, Course-level Learning Outcomes, Teaching-Learning Process, Blended Learning, Assessment and Evaluation, Keywords, References and Appendices. The experts of various Boards of Studies and Faculties contributed to a large extent in giving the final shape to the revised curriculum of each programme.

To ensure the implementation of curricular reforms envisioned in NEP-2020, the University has decided to implement various provisions in a phased manner. Therefore, the curriculum may be reviewed annually so as to gradually include all relevant provisions of NEP-2020.

Programme Outcomes (PO)

On completing **Masters in Faculty of Science,** the students shall be able to realize the following outcomes:

PO	Description
PO1	Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevance in day-to-day life.
PO2	Acquire the skills in planning and performing and handling scientific instruments during laboratory experiments
PO3	Realize how developments in one science subject help in the development of other science subjects and vice-versa.
PO4	Able to think creatively (divergently and convergent) to propose novel ideas in explaining facts and figures or providing new solutions to the problems.
PO5	Learn how an interdisciplinary approach helps in providing better solutions and new ideas for sustainable development.
PO6	Develop scientific outlook not only with respect to science subjects but also in all aspects of life.
PO7	Understand the knowledge of subjects in other faculties that can greatly and effectively influence the evolving new scientific theories and inventions.
PO8	Imbibe ethical, moral and social values in personal and social life
PO9	Develop various communication skills which we will help in expressing ideas and views clearly and effectively.
PO10	Analyse the given scientific data critically and systematically and the ability to draw the objective conclusions.
PO11	The skills of observations and drawing logical inferences from scientific experiments.
PO12	Develop an overall personality by making them participate in various social and cultural activities voluntarily.
PO13	Prepare for employment in chosen field
PO14	Ability to think logically and creatively, and to solve scientific problems
PO15	Equipped to take up a suitable position in academia or industry or Institutions and to pursue a career in research.

Programme Specific Outcomes (PSO)

On completing **M.Sc. Geology Programme**, the students shall be able to realize following outcomes:

PSO1	To understand the nature of various component of earth system including planetary objects. Shall be able to design and execute things related to Basics of Geology, Scope and Importance, Geological history, Origin of life on the earth, Mineralogy, Petrology, Economic Geology, Applied Geology.
PSO2	To acquire theoretical framework for understanding the nature of geological material including rocks, minerals and fossils.
PSO3	Shall be able to perform minor research projects incorporating techniques of Basic and Advanced Geosciences. The learners will be equipped to take up a suitable position in academia or industry or Institutions and to pursue a career in research if so desired
PSO4	Shall be able to compete in national level competitive exams such as Combined Geoscientist exam, NET-JRF or GATE, State Geologist exams, International exams and can pursue career in higher studies.
PSO5	To integrate observations and theory for describing natural geological process in past and present.
PSO6	To apply the knowledge of the material and processes in mineral and energy exploration, oceanography, infrastructure development and soil and water resource applications
PSO7	To acquire state of the art knowledge in the area of research leading to identification of knowledge gaps. To understand ethics of the research.

Post Graduate Attributes

The Post graduate attributes of our students shall be aligned with those of our University in terms of touching "the life of every student through inculcating virtues of empathy, ethics, efficiency, and respect for diversity, prudence and creativity with compassion". We wish to achieve this through rigorous teachings and research efforts, which remains the basic tenet of our teaching-learning philosophy. The following are the Post graduate attributes of the subject:

- Broaden the outlook and attitude, develop the current skills and abilities, learn new one to excel in studies and career, grow into responsible global citizens.
- Contour the academic career of the students, make them employable, enhance research acumen and encourage the participation in co-curricular and extracurricular activities.
- Instill skills and abilities to develop a positive approach and be self-contained to shape one's life and also that of colleagues and peers.
- Demonstrate behavioural attributes for the enhancement of soft skills, socialistic approach and leadership qualities for successful career and nurture responsible human being.
- Provide highly skilled and knowledgeable human resources for mining and mineral sector, Gem industry, environment management, space research and research institutes.

Scheme of Teaching, Examination and Courses of Study (Syllabus) in M.Sc. Geology Programme

M.Sc. Geology Programme of Two Years duration is divided into Four Semesters.

- Each Semester will have Four Theory Papers and Internal assessment.
- Each Semester will have Two Practical Papers, related to four Theory Papers, each of 100 Marks including internal assessment and field trainings.

Eligibility:

- B.Sc. with Geology as one of the subject/ B.Sc. honours in Geology.

Terms and Conditions

The students seeking admission to M.Sc. Geology course are hereby informed that they are supposed to adhere to the following rules:

- A minimum of 75% attendance for lectures/practical is the pre-requisite for Grant of Terms.
- Fieldwork is a compulsory component/part of each semester. Students not attending the tour and training programme shall not be eligible to appear in university examination. There will be a continuous evaluation of the field work. The evaluation will be based on following four heads:

Heads	**Marks**	**Evaluating Authority**
Performance of the student in the field	2	By faculty members accompanying the field tour
Punctuality, enthusiasm, and aptitude of students while completing the report	2	By faculty members accompanying the field tour
Tour report	4	By members of Examination committee
Viva-voce	2	By members of Examination committee

Teaching Work-load:

- Each Theory Paper will have four lectures, each of 60 minutes duration, per week.
- Each Practical Paper will have eight lectures, each of 60 minutes duration, per week.
- **Seminars and Tutorials:**
- Regular Seminars, class tests and Tutorials based on each paper will be conducted in the Department from time to time.
- It is compulsory for every student. Students not completing their seminars, tests and tutorials will not be allowed to appear for practical examination.

Evaluation in the Theory papers in First, Second, Third and Fourth Semesters:

For the **Continuous Internal Assessment** of the candidates, 10 marks shall be awarded by the teacher(s), teaching that course, for which the breakup of the marks will be as follows:

(a) Class Test(s)	8 marks
(b) Assignment(s)/ Presentation(s)	8 marks
(c) Class Participation, interaction, punctuality, performance and aptitude	4 marks

Where more than one teacher is teaching a paper, the average of the marks awarded by all the teachers shall be considered.

For the **Semester End Examination**, the theory question paper for each course will be of 80 marks. **A course will contain 5 units**. The question paper shall contain three sections. Section A (10 marks) shall contain 10 questions two from each Unit. Each question shall be of 1 mark. All the questions are compulsory. Section A will be prepared such that questions i through v are multiple-choice questions, while questions vi through x will be fill-in-the-blank questions. Section B (25 marks) shall contain 5 questions (two from each unit with internal choice). Each question shall be of 5 marks. The candidate is required to answer all 5 questions. The answers should not exceed 150 words. Section C (45 marks) shall contain 5 questions, one from each Unit. Each question shall be of 15 marks. The candidate is required to answer any three questions by selecting these three questions from different units. The answers should not exceed 400 words.

Distribution of Credits

SEMESTER I										
Paper Code	Paper Name	Code	L	T	P	Total Credits	Maximum Marks			Minimum Passing Marks(%)
							Internal Marks	External Marks	Total Marks	
GEOL6.5AECT100	Fundamentals of Field Geology	AEC	2	0	0	2	20	80	100	Non-CGPA S/NS*
GEOL6.5DCCT101	Geomorphology and Geotectonics	DCC	3	1		4	20	80	100	36
GEOL6.5DCCT102	Crystallography and Mineralogy	DCC	3	1		4	20	80	100	36
GEOL6.5DCCT103	Palaeontology	DCC	3	1		4	20	80	100	36
GEOL6.5DCCT104	Principles of Stratigraphy and Precambrian Geology of India	DCC	3	1		4	20	80	100	36
GEOL6.5DCCP105	Lab: Geomorphology, Geotectonics,Crystallography and Mineralogy	DCC	0	0	4	4	20	80	100	36
GEOL6.5DCCP106	Lab: Palaeontology, Principles of Stratigraphy and Precambrian Geology of India	DCC	0	0	4	4	20	80	100	36
Total Credits						26				
Total Marks							600			

- DCC: Discipline centric compulsory course. AEC: Ability Enhancement course.
- S/NS*=Satisfactory or Not satisfactory.
- A candidate shall be required to obtain 36% marks to pass in theory, practical and internals separately.
- For Internal Evaluation of 20 Marks {15 Marks theory paper + 05 Marks practical paper}
- L=Lecture; T=Tutorial; P=Practical

SEMESTER II										
Paper Code	**Paper Name**	**Code**	**L**	**T**	**P**	**Total Credits**	**Maximum Marks**			**Minimum Passing Marks(%)**
							Internal Marks	**External Marks**	**Total Marks**	
GEOL6.5VACT200	National and Human Values	VAC	2	0	0	2	20	80	100	Non-CGPA S/NS*
GEOL6.5DCCT201	Phanerozoic Stratigraphy of India	DCC	3	1		4	20	80	100	36
GEOL6.5DCCT202	Structural Geology	DCC	3	1		4	20	80	100	36
GEOL6.5DCCT203	Igneous and Metamorphic Petrology	DCC	3	1		4	20	80	100	36
GEOL6.5DCCT204	Geochemistry and Analytical Techniues	DCC	3	1		4	20	80	100	36
GEOL6.5DCCP205	Lab: Phanerozoic Stratigraphy of India and Structural Geology	DCC	0	0	4	4	20	80	100	36
GEOL6.5DCCP206	Lab: Igneous and Metamorphic Petrology Geochemistry and Analytical Methods	DCC	0	0	4	4	20	80	100	36
Total Credits						**26**				
Total Marks							**600**			

- DCC: Discipline centric compulsory course. AEC: Ability Enhancement course.
- S/NS*=Satisfactory or Not satisfactory.
- A candidate shall be required to obtain 36% marks to pass in theory, practical and internals separately.
- For Internal Evaluation of 20 Marks (15 Marks theory paper + 05 Marks practical paper}
- L=Lecture; T=Tutorial; P=Practical

SEMESTER III										
Paper Code	**Paper Name**	**Code**	**L**	**T**	**P**	**Total Credits**	**Maximum Marks**			**Minimum Passing Marks(%)**
							Internal Marks	**External Marks**	**Total Marks**	
GEOL6.5SDCT300	Seminar + Academic Writing	SAW	2	0	0	2	20	80	100	Non-CGPA S/NS*
GEOL6.5DCCT301	Remote Sensing and Mineral Exploration	DCC	3	1		4	20	80	100	36
GEOL6.5DCCT302	Sedimentology	DCC	3	1		4	20	80	100	36
GEOL6.5DCCT303	Geo-energy Resources	DCC	3	1		4	20	80	100	36
GEOL6.5DCCT304	Economic Geology and Mineral Economics	DCC	3	1		4	20	80	100	36
GEOL6.5DCCP305	Lab: Remote Sensing, Mineral Exploration and Sedimentology	DCC	0	0	4	4	20	80	100	36
GEOL6.5DCCP306	Lab: Geo-energy Resources, Economic Geology and Mineral Economics	DCC	0	0	4	4	20	80	100	36
Total Credits						**26**				
Total Marks							**600**			

- DCC: Discipline centric compulsory course. AEC: Ability Enhancement course.
- S/NS*=Satisfactory or Not satisfactory.
- A candidate shall be required to obtain 36% marks to pass in theory, practical and internals separately.
- For Internal Evaluation of 20 Marks {15 Marks theory paper + 05 Marks practical paper}
- L=Lecture; T=Tutorial; P=Practical

SEMESTER IV										
Paper Code	**Paper Name**	**Code**	**L**	**T**	**P**	**Total Credits**	**Maximum Marks**			**Minimum Passing Marks(%)**
							Internal Marks	**External Marks**	**Total Marks**	
GEOL6.5AECT400	General Health and Hygiene	AEC	2	0	0	2	20	80	100	Non-CGPA S/NS*
GEOL6.5DCCT401	Environmental Geology and Engineering Geology	DCC	3	1		4	20	80	100	36
GEOL6.5DCCT402	Hydrogeology	DCC	3	1		4	20	80	100	36
GEOL6.5DCCT403	Oceanography and Climatotology	DCC	3	1		4	20	80	100	36
GEOL6.5DCCT404	Mining Geology	DCC	3	1		4	20	80	100	36
GEOL6.5DCCP405	Lab: Environmental Geology, Engineering Geology and Hydrogeology	DCC	0	0	4	4	20	80	100	36
GEOL6.5DCCP406	Lab: Oceanography,Climatotology and Mining Geology	DCC	0	0	4	4	20	80	100	36
Total Credits						**26**				
Total Marks							**600**			

- DCC: Discipline centric compulsory course. AEC: Ability Enhancement course.
- S/NS*=Satisfactory or Not satisfactory.
- A candidate shall be required to obtain 36% marks to pass in theory, practical and internals separately.
- For Internal Evaluation of 20 Marks {15 Marks theory paper + 05 Marks practical paper}
- L=Lecture; T=Tutorial; P=Practical

M.SC. GEOLOGY PROGRAMME DETAILS:

SEMESTER I

Theory Papers	Course Nomenclature	Duration	Max. Marks
GEOL6.5AECT100	Fundamentals of field Geology	(Internal Non-CGPA)	
GEOL6.5DCCT101	Geomorphology and Geotectonics	3 Hrs.	80
GEOL6.5DCCT102	Crystallography and Mineralogy	3 Hrs.	80
GEOL6.5DCCT103	Palaeontology	3 Hrs.	80
GEOL6.5DCCT104	Principles of Stratigraphy and Precambrian Geology of India	3 Hrs.	80
GEOL6.5DCCP105	Lab: Geomorphology, Geotectonics,Crystallography and Mineralogy	3 Hrs.	80
GEOL6.5DCCP106	Lab: Palaeontology, Principles of Stratigraphy and Precambrian Geology of India	3 Hrs.	80

GEOL6.5AECT100 FUNDAMENTALS OF FIELD GEOLOGY

Course objectives

- The course shall provide in depth knowledge in the field geology to the students.
- To Promotes interest of the student for studies in field of earth sciences.
- To prepare students for practical skills, including geological mapping, surveying, field photography, data and sample collection in the field
- The students shall be capable of appreciating the existence and exploration of natural resource system.
- To make students fully competent to undertake any job in harsh conditions the field of Geology.

Course Outcomes:

At the end of the course, the student shall be able to

- Understand basic knowledge, concept and importance of field Geology.
- Understand the mineral structures and their formation and classification.
- Understand to identifying the different types of rocks, their nature of origin, classification etc.
- Understand to prepare geological maps on the basis of data collections.

Course Description

UNIT I

Introduction to Field Geology: Elementary aspects. Scope and plan of geological field work, Field equipment and field safety, Clinometer and Brunton compass, Bearings and attitudes in fields, Field observations, degree of accuracy in field work.

UNIT II

Geological maps, topographic Maps, Geographic Coordinates and Metric Grids, Classifications of the features, contours, scale; directions; Relation of Topography to geological mapping; uses of profile section in geological mappings, Procedure in Geological mappings; description of Geological maps, Nature of Legend, requisite data of the completed geological map.

UNIT III

Geological Mapping-Principles and aims, Base Map, Equipment for mapping, Position Finding on Maps and field data on a base map. Methods of geological Mappings:-Traverse, Contact, Exposure, drilling, underground mapping and photogeology.

UNIT IV

Field Measurements and Techniques: Measuring, plotting and recording of dip and strike. Measuring linear features. Folds, faults, joints, thrust and unconformities. Map symbols. Rocks, Fossils and Ores: Identification, description and naming of rock in field. Lithostratigraphy and sedimentary rocks: structures. Fossils: identification and nomenclature.

UNIT V

Sampling: Selections, size and labelling. Samples for thin-sections, Orientated samples, Samples for geochemical analysis, Samples for mineral extraction, Samples for fossils. Survey. Field Photography. Field Maps and Field Notebooks, Geological Field Reports.

Recommended Readings:

1. Basic Geological Mapping: John W. Barnes and Richard J. Lisle
2. A Guide to Field Geology: N. W. Gokhale (CBS Publications).
3. Guide to Field Geology: S. M. Mathur.

GEOL6.5DCCT101 GEOMORPHOLOGY AND GEOTECTONICS

Course objectives

- This course aims to develop a holistic understanding about different concepts of Geomorphology and different geomorphic Cycles in rocks and their significance.
- It will also help the student in understanding the Tectonic theories and processes responsible.

Course Outcome:

After learning this course a student shall able to

- Describe the different Geomorphologic and Geotectonic features.
- Understand the geomorphometrics and tectonics.

Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit - I

Fundamental concepts of Geomorphology. Analysis of geomorphic process: Exogenic, Endogenic and Extra-terrestrial Processes. Concept of morphogenetic regions. Fluvial geomorphic Cycle: Streams and valleys, Classification of valleys; Stages in drainage system evolution, their pattern, textural implications; rejuvenation. Peniplaination concept. Erosional and depositional features associated with fluvial cycles.

Unit - II

Landforms, their development, types and nature. Landforms in relation to structure and tectonics. Karst topography, Glaciers: types & characteristics. Erosional and depositional features associated with glacial cycles. Arid cycles: origin and types of deserts, eolian landforms; expansion and control of desertification in India.

Unit - III

Coastal Geomorphology. Geomorphology of shorelines and ocean floors, Geomorphometric analysis and modeling. Major geomorphological sub division of India, their characteristics and evolution.

Unit – IV

Crust: composition, seismic, gravity and magnetic characters. Heat flow; Gravity & Magnetic Anomalies. Mantle: different zones; seismic characters; gravity anomalies; Core. Crustal types: shields, platforms, mountain chains, rift valleys, mid oceanic ridges, trenches, island arcs and ocean basin. Crustal Provinces.

Unit - V

Orogeny and epeirogeny, Himalayan orogeny, Supercontinent cycle, Mantle plume and their role in geological activity. Tectonic theories: Isostasy, Geosynclines, Sea-floor spreading, Palaeomagnetism. Continental drift, Plate Tectonics, Mechanism of plate movement.

Suggested readings:

1. Spencer, E.W. – Introduction to the Earth's Crust (McGraw Hill)
2. Wylie, P. J. – Dynamic Earth (J. Wiley & Sons)
3. Holmes A. – Physical Geology (Nelson)
4. Strahler – Physical Geology.
5. Summerfield, M.A. – Geomorphology and Global Tectonics. Springer Verlag.
6. Moores, P. and Twiss, R.J., - Tectonics. Freeman.
7. Bloom, A. – Geomorphology (Prentice Hall)
8. Thornbury, W.D. – Principles of Geomorphology (J. Wiley & Sons)
9. Lobeck, A.K. – Geomorphology (Mc-Graw Hill)
10. Savinder Singh: Physical Geography.

GEOL6.5DCCT102 CRYSTALLOGRAPHY AND MINERALOGY

Course objectives

- To develop a holistic understanding about different concepts of Crystallography and its Laws
- To help student in understanding crystal classes.
- To identify and describe minerals.
- To identify and describe minerals under microscope.

Course Outcome

After learning this course a student shall able to

- Describe the mineral groups and crystals system.
- Understand the physical, optical properties and projections.

Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit -I

Crystallography: Crystal growth, Symmetry operations. Laws of crystallography. Goniometery. Crystallographic axes and axial angles, notation of faces on parameters of Weiss and Miller indicies. Thirty two crystal classes. Crystal projections: spherical, stereographic and gnomonic

Unit -II

Space lattices. Symmetry elements. X– Ray crystallography: Bragg's equation; powder and single crystal methods, Laue method. Twinning: Twin crystals, Twin axis, twin planes, composition planes, Twin Laws and different types of twinning.

Unit -III

Mineralogy: classification of mineral kingdom. Physical and optical properties of minerals: Petrological microscope: construction and working. Ordinary and Polarized light, methods to obtain polarized light, Refractive index: Methods of its determination, Critical angle, Reflection and Refraction. Isotropism and anisotropism. Birefringence: Double refraction. Vibration direction, interference figures, optic sign, optic axial angle; indicatrix; dispersion; universal stage and Berek compensator. Extinction: Definition, types and extinction angle, Interference colours and interference colour chart

Unit –IV

Mineralogy of native elements, sulphides, sulfosalts, oxides, hydroxides and carbonates. Silicate Minerals: definition and their classification based on silicate structure. Silicate structures: Isomorphism, Polymorphism, Allotrophy and Pseudomorphism. Neso-silicates– Olivine group, Garnet group, Kyanite, Andalusite, Sillimanite. Soro-silicates– Epidote group. Cyclo Silicate- Beryl, Tourmaline, Axinite, Cordierite

Unit -V

Ino-silicates–Pyroxene group, Pyroxinoid group and Amphibole group. Phyllo-silicates: Mica group, Chlorite, Talc. Tecto silicates-Feldspar group, Feldspathoid group, Zeolite group, Quartz, and other forms of Silica. Gem minerals: gem properties and varieties.

Suggested Readings:

1. Phillips, F.C. – An Introduction to Crystallography (ELBS)
2. Burger, M.J. – Elementry Crystallography (J. Wiley & Sons)
3. Evans, R.C. – Crystal Chemistry (Cambridge University Press)
4. Dana, E. Ford W.E. – A Text book of Mineralogy (Asia Public House)
5. Deer, Howie & Zussman – Introduction to Rock Forming Minerals (ELBS)
6. Winchel & Winchel – Elements of Optical Mineralogy (ELBS)
7. Read, H.H. – Rutley's Elements of Mineralogy (Thomas Murby & Co.)
8. Mason, Berry – Minerology. (Asian Pub.)
9. Sharma, N.L. – Determinative Tables (ISM, Dhanbad).
10. Klein, C.and Hurlbut, Jr., C.S.,- Manual of Mineralogy. (J. Wiley & Sons)

GEOL6.5DCCT103 PALAEONTOLOGY

Course objectives

- To give detailed knowledge of different fossils and their applications, Organic Evolution, Micropalaeontology.
- Identification of the Mega and Micro fossils.

Course Outcome: After learning this course a student will be able to

- Describe the different types of fossils.
- Understand the evolution, morphology and geological history.

Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit - I

Organic Evolution. Nomenclature of organisms. Classification of organisms. Distribution, migration, dispersal and extinction of animals and plants. Fossil: Techniques of collection, separation, preparation, preservation and nomenclature of micro and mega fossils. Graptolites: their systematic position, evolution and geological history.

Unit - II

Anthozoa: Morphology and geological history of Tetracoralla, Hexacoralla and Tabulata; appearance of septa in Tetracoralla. Echinoidea: Change in symmetry, variation in oculogenital system; ambulacral areas and compound plates, classification and geological history. Trilobita: Growth stages, evolutionary trends and geological history. Brachiopoda: Variation in Brachial skeleton, pedicle opening and commissure, classification and geological history.

Unit – III

Bivalvia: Evolution of hinge and dentition, adaptive modification, classification and geological history. Gastropoda: Forms, twisting of nervous system, aperture, classification and geological history. Cephalopoda: variation in shape of Conch of nautiloidea, ornamentation and siphuncle of ammonoidea and geological history.

Unit – IV

Elements of Micropalaeontology: Micro-fossils–their classification, Foraminifera: Morphology, classification and significance in palaeo-ecological studies & oil exploration. Ostrocoda: Morphology, classification, ecology and geological history. Conodonts: Morphology, classification, ecology and geological history. Nano fossils: morphology and geological distribution.

Unit -V

Palaeobotany: Study of Indian flora of the past with special reference to the Gondwana plant life. Elementary ideas about Pollens and Spores. Vertebrate Palaeontology– classification of vertebrates and their sequence through geological time. Study of Indian vertebrate fauna with special reference to Siwaliks. Evolutionary trends of Horse, Elephant, Man and Giraffe.

Suggested Readings:

1. Shrock & Twenhofel – Principles of Invertebrate Palaeontology (McGraw Hill) .
2. Moore, Laliker & Fisher – Invertebrate fossils (McGraw Hill).
3. Colbert, E.H. – Evolution of the Vertebrates (J. Wiley & Sons).
4. Woods, H. – Invertebrate Palaeontology (CBS).
5. Jain and Anantharaman – Introduction to Palaeontology.
6. Black, R.M.-The Elements of Palaeontology. Cambridge University Press.

GEOL6.5DCCT104 PRINCIPLES OF STRATIGRAPHY AND PRECAMBRIAN GEOLOGY OF INDIA

Objectives of the course

- To impart basic knowledge about Stratigraphy and its Principles.
- Provide knowledge of supergroups deposited in India during different geological time periods and life preserved in them.

Course Outcomes

After learning this course, a student shall be able to

- Describe the different Stratigraphy units
- Their correlation to understand the stratigraphic framework of India.

Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit - I

Principals of stratigraphy, Code of stratigraphic nomenclature. Geochronology: Radio isotopes and geological time. Development of stratigraphy and founding of stratigraphic units, Stratigraphic reltionships- lithosome, shape, vertical and lateral relationship. Principles of correlation. Time sratigraphic units. Standard stratigraphic scale and its equivalents in Indian sub- continent.

Unit - II

Geological age of fossils. Imperfection of geological records. Early history of the Earth, Precambrian geochronology and early crustal evolution. Formation and Evolution of greenstone, granite and granulite terrains. Archaean and Proterozoic tectonic patterns, Elements of palaeoecology.

Unit – III

Distribution, stratigraphic correrelation, lithological succession, geochronology and economic importance of Archaean and Palaeoproterozoic rocks of India; Dharwar Province, Eastern Ghat Province, Central Indian Province, and Singhbhum -Odisha Province.

Unit – IV

Meso and Neoproterozoic rocks of India; Cuddapah-Kurnool, Kaladgi, Bhima, Pakhal and Vindhyan basins their distribution, stratigraphic correlation, lithological succession and economic importance Precambrian- Cambrian boundary problem in India.

Unit – V

Precambrian geology of Rajasthan; Banded Gneissic Complex (Bhilwara Supergroup), Aravalli Supergroup, Delhi Supergroup, Vindhyan Supergroup, Marwar Supergroup, Post Delhi Intrusives and Malani Igneous Suite.

Suggested Readings:

1. Krumbein and Sloss – Stratigraphy and Sedimentation (WH Freeman & Co.)
2. Dunber, C.O. & Rodgers, J. – Princples of Stratigraphy (J. Wiley & Sons)
3. Ravindra Kumar – Introduction of Historical Geology and Principles of Stratigraphy
4. Rankama, K. – The Geologic Systems-The Pre cambrian Vol.-III Ed. (J. Wiley & Sons
5. Eicher, Don, L. – Geologic Time (Prentice Hall)
6. Sinha Roy, S. Malhotra, G & Mohanty, M. – Geology of Rajasthan (Geol. Soc. Ind.
7. Roy and Jakhar- Geology of Rajasthan, Scientific Publ. Jodhpur

M.Sc. Semester I Practicals

Scheme of Examination (Practical)

Maximum Marks: 200 (160 External + 40 Internal)

Duration: 6 Hrs **Minimum Passing Marks: 36%**

Practical Course

GEOL6.5DCCP105Lab: Geomorphology, Geotectonics,Crystallography and Mineralogy

Maximum Marks: 100 (20 Internal Assessment +80 End Semester Exam)

Exam Duration: 3 Hrs

(Practicals of Geomorphology and Geotectonics)

Geomorphology & Geotectonics **30 Marks**

1. Study of topographic maps and their interpretation.
2. Representation of geomorphic features.
3. Geomorphic surveys, leveling and contouring.
4. Geomorphometric analysis

Crystallography **15 Marks**

1. Identification and description of crystal models in hand specimens.
2. Construction of Stereographic projections and determination of axial Ratio.
3. Problems related to stereographic projection of crystals.

Mineralogy **15 Marks**

1. Identification of important rock forming minerals by physical examination.
2. Identification of important rock forming minerals by optical examination.
3. Determination of 2V and pleochroic schemes of important rock forming minerals.

Record **10 Marks**

Viva-Voce **10 Marks**

Mid Semester Assessment (Attendence-4, Seminars -6 and Field report-10) 20 Marks

Practical Course

GEOL6.5DCCP106 Lab: Palaeontology, Principles of Stratigraphy and Precambrian Geology of India

Maximum Marks: 100 (20 Internal Assessment +80 End Semester Exam) Exam Duration: 3 Hrs

(Practicals of palaeontology and Principles of Stratigraphy & Precambrian Geology of India)

Palaeontology **30 Marks**

1. Identification, drawing and description of common representatives of Fossil groups

2. Sketching of evolutionary trends of important invertebrate fossils groups. Evolutionary trends of vertebrates

Principles of Stratigraphy & Precambrian Geology of India **30 Marks**

1. Study of rocks in Hand specimens from Precambrian terrain of India.

2. Showing boundaries of the Precambrian terrains of India on map.

3. Stratigraphic and Palaeogeographic maps with special reference to India.

4. Preparation of Lithology and their correlation, correlation problems

Record **10 Marks**

Viva-Voce **10 Marks**

Mid Semester Assessment (Attendence-4, Seminars -6 and Field report-10) 20 Marks

General Geological tour and Submission of report and Viva-voce before examination.

Semester II

Marking Scheme for External Exams

Theory Papers	Course Nomenclature	Duration	Max. Marks
GEOL6.5VACT200	National and Human Values	(Internal Non-CGPA)	
GEOL6.5DCCT201	Phanerozoic Stratigraphy of India	3 Hrs.	80
GEOL6.5DCCT202	Structural Geology	3 Hrs.	80
GEOL6.5DCCT203	Igneous and Metamorphic Petrology	3 Hrs.	80
GEOL6.5DCCT204	Geochemistry and Analytical Techniques	3 Hrs.	80
GEOL6.5DCCP205	Lab: Phanerozoic Stratigraphy of India and Structural Geology	3 Hrs.	80
GEOL6.5DCCP206	Lab: Igneous and Metamorphic Petrology Geochemistry and Analytical Techniques	3 Hrs.	80

GEOL6.5DCCT201 PHANEROZOIC STRATIGRAPHY OF INDIA

Course objectives

- To impart basic knowledge about Phanerozoic Stratigraphy.
- To provide knowledge about supergroup of India during phanerozoic and life preserved in them.

Course Outcomes After learning this course, a student will be able to

- Describe the different Stratigraphy units and their correlation to understand the Phanerozoic stratigraphic framework of India and Rajasthan.

Marks: Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit - I

Precambrian-Cambrian boundary problem. Succession, fauna, flora, sedimentation, palaeogeography, age problems and regional correlation of the Palaeozoics of Indian sub-continent.

Unit - II

Nomenclature, extent, division, succession, sedimentation, structures, palaeogeography; flora, fauna and regional correlation of the following: Triassics, Jurassics, Cretaceous of India. Cretaceous –Tertiary (K T) boundary problem.

Unit – III

Gondwana Supergroup: Succession, fauna, flora, sedimentation, palaeogeography, age. Deccan Traps: Succession, fauna, flora, age problems and regional correlation, Intertrappean and Infratrappean beds.

Unit – IV

Tertiary of Extra Peninsular India with special reference to Assam Lesser Himalayas. Tertiary of coastal region. Neogene-Quaternary boundary problem.

Unit -V

Phanerozoic Stratigraphy of Rajasthan. Quarternary Geology of Rajasthan.

Suggested Readings:

1. Pascoe, E.H. – A Manual of Geology of India & Burma (GSI)
2. Ravindra Kumar – Introduction of Historical Geology and Principles of Stratigraphy (CBS)
3. Sinha Roy, S. Malhotra, G & Mohanty, M. – Geology of Rajasthan (Geol. Soc. Ind.)
4. Roy and Jakhar- Geology of Rajasthan, Scientific Publ. Jodhpur

GEOL6.5DCCT202 STRUCTURAL GEOLOGY

Course objectives

- To develop a holistic understanding about different structures in rocks and their significance.
- It will also help the student in understanding the processes responsible for the formation of various types of structures.

Course Outcome: After learning this course a student will be able to

- Describe the different structural elements
- Understand the application of forces in the formation of structures.

Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit - I

Concept of Stress and Strain; Two-dimensional analysis of stress and strain; Types of strain ellipses and ellipsoids- their properties and geological significance; Strain markers, Behaviour

of rocks under stress. Mohr circle. Various states of stress and their representation by Mohr circles. Brittle and ductile behavior of rocks.

Unit – II

Folds: Morphology, classification, mechanism and recognisation. Superimposed folding and interference patterns. Structural analysis in terrains with multiple deformations. Stereographic projections and π and β diagrams

Unit – III

Fault- Morphology, classification, mechanism and recognisation. Effects of faulting on outcrop pattern. Fault-related folding.

Unit – IV

Joint –Nomenclature, types, origin and significance. Types of Linear structures and their tectonic significance. Basic concept of cleavage, Lineation and Foliation and their origin and types.

Unit – V

Shear zones; Brittle and ductile shear zones; Geometry and products of shear zones. Shear zone indicators. Balanced Cross section. Geological mapping: principles, procedure.

Suggested Books:

1. Ragan, D.M. – Structural Geology (J. Wiley & Sons)
2. Badgley, P.C. – Structural Geology for Exploration Geologists (Oxford Univ. Press)
3. Billings, M.P. – Structural Geology Hobbs, B.E. Means,
4. W.D. & Williams P.F. – An outline of Structural Geology (J.Wiley & Sons)
5. Ramsay, J.G. – Folding & Fracturing of Rocks (McGraw Hill)
6. Davis, G.R.- Structural Geology of Rocks and Region. John Willey.
7. Ramsay, J.G. and Huber, M.I. – Modern Structural Geology. Vol I &II. Academic Press.
8. Hakkon Fossen- Structural Geology, Cambridge University Press

GEOL6.5DCCT203 IGNEOUS AND METAMORPHIC PETROLOGY

Course objectives

- To develop a holistic understanding about rocks, their genesis, occurrences etc.
- To understand the processes responsible for the formation of various types of rocks.

Course Outcome: After learning this course a student will be able to

- Describe the different types of igneous and metamorphic rocks.
- Understand the petrography and petrogenesis.

Marks: Marks: Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit-I

Composition, constitution & behaviour of magma. Magma types and their classification. Origin of magma. Differentiation and assimilation of magma. End-stage crystallisation of magma. Magma generation and its relation with plate margins. Fabric study of plutonic and volcanic rocks. Classification of Igneous rocks. Petrographic provinces of India.

Unit-II

Crystallisation process in silicate melts including system: Albite- Anorthite, Albite-Anorthite Orthoclase, Foresterite- Silica, Leucite-Silica, Diopside- Anorthite-Albite, Diopside-Foresterite-Silica, Nepheline-Kaliophylite-silica, Foresterite- Fayalite-Silica; Reaction principles. Forms, structure and textures of igneous rocks.

Unit-III

Petrography, mode of occurrence and petrogenesis of the following rock groups and associations: Basic and Ultrabasic plutonic association; Granite and Granodiorite plutonic association; Nepheline Syenite, Ophiolites and cumulates, Anorthosite and Pegmatite; Tholeites and alkali Olivine basalt. Dacite and Rhyolite association of Orogenic regions.

Unit-IV

Metamorphism: concept, factors and types. Texture and structure of metamorphic rocks. Phase rule. Concept of the depth zone, zone of progressive metamorphism. Retrogressive metamorphism; stress and anti-stress minerals. Anatexis and migmatites. ACF, AKF, & AFM diagrams and their significance.

Unit- V

Detailed study of facies of contact and regional metamorphism. Paired metamorphic belts. Mineralogical and textural changes accompanying progressive regional metamorphism of mafic and ultramafic rocks, pelites and carbonate rocks. Metasomatism and metamorphic differentiation. Petrographic and petrogenetic study of important metamorphic rocks; granulites, charnockites and eclogites etc; Ultra-high temperature, ultra-high pressure and ocean floor metamorphism and their significance.

Suggested Readings:

1. Bowen, N.L. – Evolution of Igneous rocks (Princeton University Press)
2. Best – Igneous and Metamorphic Petrology (CBS)
3. Winkler H.G.F. - Petrogenesis of Metamorphic Rocks (Springer-Verlog)
4. Miashiros – Metamorphism and metamorphic Rocks (George Allen University)
5. Moorehouse – A study of Thin Sections (CBS)
6. Ghose, M.K. – Igneous Petrology (World Press Pvt. Ltd., Kolkata)
7. Chatterjee, S.C. – Igneous & metamorphic Rocks
8. Johanneson, A – A Descriptive Petrology of Igneous Rocks –Vol. I-IV
9. Turner, F.J. - Metamorphic Petrology. Mc Graw Hill.
10. Philipots, A. - Igneous and Metamorphic Petrology. Prentice Hall.
11. J. D. winter - Principles of. Igneous and Metamorphic Petrology

GEOL6.5DCCT204 GEOCHEMISTRY AND ANALYTICAL TECHNIUES

Course objectives

- This course aims to develop a holistic understanding about Geochemistry and Isotope Geochemistry.
- It will also help the student in understanding the geochemical cycles.

Course Outcome:

After learning this course, student will be able to

- Describe the different geochemical aspects.
- Understand the Analytical techniques.

Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit -I

Introduction of Geochemistry and Cosmochemistry. Chemical composition and properties of Earth's layers. Gold-Schmidt geochemical classification. Concept of enthalpy, free energy; chemical potential; fugacity, Structure and types of atoms. Internal structure of atoms, atomic weights. Types of chemical bonding. Ionic radii. Coordination number. Atmosphere: its layers, chemical composition and evolution of Atmosphere. Meteorites

Unit -II

Lattice energy. Ionization potential. Electronegativity. Pauling's rule. Isomorphism and polymorphism. Principles of ionic substitution in minerals. Eh and pH diagrams, limits of Eh and pH in nature; oxidation and reduction in sedimentation. Geochemical cycle; Minor cycle and Major cycle. Geochemical classification of elements. Distribution of elements in igneous, metamorphic and sedimentary rocks. Periodic table with special reference to rare earth elements and transition elements.

Unit -III

Isotope Geochemistry: stable isotopes, oxygen isotopes, sulphur isotopes, carbon isotopes, hydrogen isotopes. Use of isotope geochemistry in solving problems of ore genesis, ground water and petrogenesis. Element analysis of rocks and minerals. Geochemistry of Uranium and Lithium.

Unit -IV

Concept of geochemical-biogeochemical cycling and global climate; Hydrosphere: the hydrological cycle, composition of natural waters, some characteristics of river waters and ground water; Biosphere: Introduction: the mass of the biosphere: composition of the biosphere: biogenic deposits; geochemical cycle of carbon.

Unit -V

Principles and geological applications of cathodoluminiscence, thermoluminiscence, atomic absorption spectophotometry, XRF spectrometry, FTIR and XRD. Working knowledge of AAS, Flame- photometer, DTA, ICP spectrometer, UV- IR spectophotometer and working techniques.

Suggested Readings:

1. Mason, B. – Principles of Geochemistry (McGraw Hill)
2. Kraushopf – Introduction to Geochemistry (McGraw Hill)
3. Fyfe – Geochemistry (Clereton Press Oxford)
4. Sharma, N.L. – Determinative Tables (ISM, Dhanbad).
5. Mason, B. and Moore, C.B. - Introduction to Geochemistry. Wiley Eastern.
6. Faure, G. - Principles of Isotope Geology. John Wiley.
7. Govett, G.J.S. - Hand Book of Exploration Geochemistry. Elsevier

M.Sc. Semester II Practicals

GEOL6.5DCCP205 LAB: PHANEROZOIC STRATIGRAPHY OF INDIA AND STRUCTURAL GEOLOGY

Maximum Marks: 100 (20 Internal Assessment +80 End Semester Exam)

Exam Duration: 3 Hrs

Phanerozoic Stratigraphy **30 Marks**

1. Study of rocks in Hand specimens from Phanerozoic terrain of India.
2. Showing boundaries of the Phanerozoic terrains of India on map.
3. Stratigraphic and Palaeogeographic maps with special reference to India.
4. Preparation of Lithologs and their correlation, correlation problems.

Structural Geology **30 Marks**

1. Solution of structural problems by stereographic and orthographic projection methods.

2. Identification of structural elements and their chronology in hand specimens.

3. Completion of outcrop patterns.

4. Study of Geological Maps, Preparation of Geological sections, determination of Thickness of beds, Geological History

Record **10 Marks**

Viva-Voce **10 Marks**

Mid Semester Assessment (Attendence-2, Seminars-3 Field report -5) **20 Marks**

GEOL6.5DCCP206 LAB: IGNEOUS AND METAMORPHIC PETROLOGY GEOCHEMISTRY AND ANALYTICAL TECHNIQUES

Maximum Marks: 100 (20 Internal Assessment +80 End Semester Exam)

Exam Duration: 3 Hrs

Igneous and Metamorphic Petrology **30 Marks**

1. Description and identification of Igneous and Metamorphic rocks in Hand Specimens and under microscope.
2. Petrographic methods and calculation of CIPW norms and Niggli values and their plotting.
3. Petrochemical calculations and representation (ACF & AKF diagrams)
4. Phase diagrams of important binary and ternary crystallization systems

Geochemistry and Analytical techniques **30 Marks**

1. Preparation and interpretation of geochemical maps
2. Rock/ sediments/ water/ soil analysis.
3. Variation diagrams, REE normalized plots and their interpretations.

Record **10 Marks**

Viva-Voce **10 Marks**

Mid Semester Assessment (Attendence-2, Seminars-3 Field report -5) **20 Marks**

Structural mapping camp, submission of report and viva-voce before examination.

Semester III

Marking Scheme for External Exams

Theory Papers	Course Nomenclature	Duration	Max. Marks
GEOL6.5SDCT300	Seminar + Academic Writing	(Internal Non-CGPA)	
GEOL6.5DCCT301	Remote Sensing and Mineral Exploration	3 Hrs.	80
GEOL6.5DCCT302	Sedimentology	3 Hrs.	80
GEOL6.5DCCT303	Geo-energy Resources	3 Hrs.	80
GEOL6.5DCCT304	Economic Geology and Mineral Economics	3 Hrs.	80
GEOL6.5DCCP305	Lab: Remote Sensing, Mineral Exploration and Sedimentology	3 Hrs.	80
GEOL6.5DCCP306	Lab: Geo-energy Resources, Economic Geology and Mineral Economics	3 Hrs.	80

GEOL6.5DCCT301 REMOTE SENSING AND MINERAL EXPLORATION

Course objectives

- To develop a holistic understanding about Remote Sensing and Mineral Exploration.
- To help the student in understanding the surface and sub-surface exploration and Application of Remote Sensing.

Course Outcome: After learning this course, a student will be able to

- Describe the different mineral exploration techniques.
- Understand the technique of RS and photogeology.

Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit I

Maps and aerial photographs; Aerial photographs- types, errors and distortion. Rectification. Vertical exaggeration and its estimation. mosaic, preparation of base map by radial triangulation methods. Stereoscopic vision, pseudoscopic vision, measuring instrument and their uses, calculation of height of an object by parallax method.

Unit- II

Remote sensing. Aero visual survey. Infrared photography, multiple band photography. Imageries. Types of satellites. RS Satellite characteristics-orbits and swaths. Sensors used in remote sensing. Satellite remote sensing and its limitations. Global and Indian space missions.

Unit- III

Application of aerial photographs, Application of Remote sensing, Geographic Information System (GIS): Principles and Applications. Vector and Raster Analysis, Global Positioning system (GPS).

Unit-IV

Exploration and its types. Surface and sub-surface exploration. Geologic mapping-reconnaissance and detailed surface mapping- Base map and topo sheet, mapping techniques for lithologies, field data collection. Subsurface mapping. Guides to ores: Targets, loci, regional guides. Classification of guides; geochemical guides; physiographic guides; mineralogical guides; stratigraphic and lithologic guides; structural guides- fractures, folds, faults.

Unit -V

Sampling and tonnage: Sampling and types; average assays. Geochemical prospecting: geochemical processes- primary and secondary; pathfinder; anomalies; geochemical field techniques and analysis; Geobotanical surveys; Subsurface exploration: drilling and types, borehole problems, borehole samplings. Geophysical prospecting- electrical, gravity, magnetic, seismic, radioactive method, well logging.

Suggested Readings:

1. Singh & Sahni – Advanced Surveying (IBH)
2. Krynine & Judd – Principles of Engineering Geology and Geotectonics (McGraw Hill)
3. Parbin Singh – Engineering and General Geology
4. Sathya Narayan swami, B.S. – Engineering Geology (Dhanpat Rai & Co.)
5. Blyth – Geology of Engineers (ELBS)
6. S. N. Pandey- Remote Sensing and Photo-Geology
7. S. K. Haldar-Mineral exploration: Principles and Applications. (Elsevier)

GEOL6.5DCCT302 SEDIMENTOLOGY

Course objectives

- This course aims to develop a holistic understanding about different sedimentary rocks.
- It will also help the student in understanding the processes responsible for the formation of various types of sedimentary rocks.

Course Outcome:

After learning this course a student will be able to

- Describe the different sedimentary rocks.
- Understand the sedimentary basins.

Course Description

Unit-I

Introduction, scope, history of development of sedimentology. Processes of sedimentation. Post depositional changes in sediments. Surface processes and rock weathering. Mineral stability. Provenance sources of sediments. Mineral composition: quartz, feldspar, rock fragments, clay minerals, heavy minerals, carbonates, cement and matrix. Soil forming processes, soil profile. Identification of clay minerals by X–Ray diffraction method. (8 Periods)

Unit-II

Texture and structures of sedimentary rocks. Trace fossils–introduction, classification, identification and description. Transportation of sediments. Settling velocity of spheres. Stock's law. Impact law. Fluid flow, movements of particles, suspension and traction transport, saltation movement, selective transportation, particle weathering during transport, sediment maturity.

Unit-III

Deposition of clastic and non–clastic sediments. Classification of sedimentary rocks. Study of common sedimentry rocks: Clastic sedimentry rocks – deposits of gravels, conglomerates, breccia, sandstone, graywacke, shale, siltstone etc. Non–clastic sedimentry rocks– limestone, dolomite, evaporites. Organic sediments.

Unit-IV

Sedimentry environment and facies: continental alluvial- fluvial, lacustrine, desert – Aeolian and glacial sedimentary systems. Shallow coastal clastics. Marine and continental evaporates. Shallow water carbonates. Deep sea basins. Volcanoclastics: onland and marine.

Unit- V

Tectonics and sedimentation. Stratigraphy and sedimentation; Reconstruction of palaeoenvironment. Basin analysis.

Suggested Readings:

1. Sengupta, S.M. – Introduction of Sedimentology (Oxford & IBH)
2. Pettijohn, F.J. – Sedimentary Rocks (CBS)
3. Slley, R.C. – Introduction to Sedimentary Rocks (Academic Press London)
4. Folk, R.L. – Petrology of Sedimentary Rocks (Hemphill Pub. Co.)
5. Allen – Sedimentary Structures
6. Thomson – Sedimentary Structures
7. Green smith – Sedimentary Petrology (CBS)
8. Krumbein and Sloss – Stratigraphy and Sedimentation (W.H. Freeman & Co.)

GEOL6.5DCCT303 GEO-ENERGY RESOURCES

Course objectives

- This course aims to develop a holistic understanding about Geo-energy Resources.
- It will also help the student in understanding the processes responsible for Geo-energy Resources.

Course Outcomes

After learning the course, a student will be able to

- Describe the geo-energy resources.
- Carry out study of basins

Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit- I

Classification of Energy Resources and Geoenergy Resources.Origin of coal. Rank, grade and type of coal. Classification of coal. Chemical characterization: proximate and ultimate analysis. Coal petrology and its application. Concept of maceral, litho types and microlithotypes. Reflectance. Coal carbonisation. Distribution and geology of Indian Coal fields, Reserves, utilization and conservation of coal in India.Coal distribution in World. Coal based industries in India. Coal bed methane.

Unit -II

Petroleum: Surface & subsurfce Occurrences, geographic location, geologic age and reservoir rock. Petroleum- chemical and physical properties. Origin of Petroleum. Migration and accumulation of Petroleum.Reservoir rock: Classification – fragmental, chemical & bio-chemical and micellaneousrocks; well logs; marine & non-marine reservoir rocks.Reservoir Pore Space: Porosity; permeability; Classification & origin of pore space; relation between Porosity & permeability.Reservoir fluids (water, oil & gas): Fluid content – source of data, distribution of gas, oil & water, classification of waters, character of oil-field water, oil field brine; Oil – measurement, chemical & physical properties; Gas - measurement, composition, impurities.

Unit- III

Reservoir Traps: Anticlinal theory; classification; structural traps; stratigraphic traps (primary & secondary); fluid traps; combination traps; salt domes. Reservoir pressure and temperature. Reservoir mechanics. Types of reservoirs of oil and gas, oil and gas traps. Geology of the petroliferous basins of India.

Unit- IV

Principles and techniques of petroleum exploration. Application of subsurface mapping in Petroleum exploration – Structural maps & sections, isopach maps, facies maps, paleogeologic & subcrop maps, geophysical maps, geochemical maps; Dry Holes.Elements of well drilling and logging. Various types of drilling in petroleum. Prospects of new discoveries of petroleum in the Indian mainland and the adjoining seas.

Unit- V

General idea about radioactivity and atomic fuels. Geology and mineralogy of Uranium and Thorium bearing minerals, their geographic distribution with reference to India. Prospecting for radioactive minerals. Non-renewable energy resources- Tidal energy and Wind Energy. Geothermal resources: classification of geothermal waters, geothermal system, geothermal regions of India and world, geothermal water deposits associated with thermal springs, industrial uses of Geothermal Energy.

Suggested Readings:

1. Landes, K.K. – Petroleum Geology (Robert, Kraieger Pub. Co.).
2. Kinghorn, R.R.F. – An Introduction to the Physics and chemistry of Petroleum (J. Wiley & Sons).
3. Stach, E. et al. – Coal Petrology.
4. Gebruder Borntraeger, Stutgart Lybach, L.,
5. Muffer, L.J.P. – Geothermal systems (J. Wiley & Sons).
6. S. Eanga Raja Rao – Coal Preparation and use (Oxford IBM Pub. Co.)
7. Armstrong, H.C. – Geothermal Energy (Span London) 7. 8. 9. 10. 11.
8. Levorson – Petroleum Geology Singh, R.D. – Principles and Practices of Modern coal Mining.
9. Taylor, G.H. et al. – Organic Petrology.
10. Gebruder Borntraeger, Stutgart. Chandra, D., Singh, R.M. and Singh, M.P., - Text Book of Coal. Tara Book Agency, Varanasi.
11. Selley, R.C. - Elements of Petroleum Geology. Academic Press

GEOL6.5DCCT 304 ECONOMIC GEOLOGY & MINERAL ECONOMICS

Course objectives

- This course aims to develop a holistic understanding about Metallic and Non - metallic Economic Minerals and the processes of formation of Mineral Depositrs and Mineral Econamics.
- It will also help the student in understanding the processes responsible formation of Mineral Depositrs.

Course Outcome:

After learning this course a student will be able to

- Describe the different ore forming processes
- Understand the distribution and uses of ores

Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit I

Magma and its relation with the mineral deposits. The development of modern theories of ore deposition. Physical and chemical characteristics of ore bearing fluids and their genesis.Fluid inclusion. Geothermometry and isotope studies in relation to ore deposits. Clasification of ore deposits, stratiform and stratabound ore deposits.Structural controls of mineralisation. Metallogenic epoch and provinces; Global metallogeny related to crustal evolution.

Unit- II

Study of the processes of formation of mineral deposits: Magmatic concentration, Sublimation, Contact metasomatism, Metamorphism, Hydrothermal, Sedimentation, Bacteriogenic, Submarine exhalative &Volcanogenic, Evaporation, Residual and Mechanical concentration, supergene sulphide enrichment.

Unit- III

Oxidation and The study of metallic mineral deposits with reference to geology, mode of occurrence, origin, uses and distribution in India of Gold, Copper, Lead-Zinc, Iron, Manganese, Aluminium, Magnesium, Chromium and strategic minerals of India.

Unit- IV

The study of non- metallic mineral deposits with reference to geology, mode of occurrence, origin, uses and distribution in India of Mica, Asbestos, Barytes, Gypsum, Limestone Garnet, Corundum, wolllastonite, calcite, quartz, feldspar, clays, Kyanite, Sillimanite, Graphite, Talc, Fluorite, Beryl and Rock phosphate, Gem minerals and radio-active minerals. Non- metallic minerals used in refractories, abrasives, ceramics, glass making materials, fertilizers, natural paints & pigments and cement.

Unit- V

Mineral Economics: Concept and scope of mineral economics. Peculiarities inherent in mineral industry. Future Sources of Mineral supply. Tenor, grade & specification. Strategic, critical and essential minerals. Conservation and substitution. Changing patterns of mineral consumption. Mining & Mineral Legislation of India: Categories of minerals for grant of concessions; Minor & Major Minerals. United Nations Framework Classification (UNFC). Economic consideration in mineral exploration: cost of exploration, macro-economic consideration, organization & management.

Suggested Readings:

1. Bateman, A.M. – Economic Mineral Deposits (J. Wiley & Sons)
2. Smirov, V.I. – Geology of Mineral Deposits (M.R. Pub)
3. Park C.F. and McDiarmid R.A. – Ore Deposits (W.H. Freeman & Co.)
4. Stanton R.L. – Ore Petrology (McGraw Hill)
5. Krishnaswami – Mineral Resources of India (CBS)

M.Sc. Semester III Practicals

Practical Course

GEOL6.5DCCP305 Lab: Remote Sensing, Mineral Exploration and Sedimentology

Maximum Marks: 100 (20 Internal Assessment +80 End Sem. Exam)

Exam Duration: 3 Hrs

Remote Sensing and Mineral Exploration 30 Marks

1. Interpretation of aerial photographs with the help of stereoscope.
2. Photogrammatric exercises.
3. Study and interpretation of satellite imageries
4. Leveling and contouring
5. Exercises related to ore reserve estimation, tonnage and grades.

Sedimentology 30 Marks

1. Common sedimentary rocks in hand specimens and in thin section.
2. Graphic representation of grain size data, histograms, cumulative curve, Frequency curves, rose diagram etc.
3. Palaeocurrent analysis and their representations.

Record 10 Marks

Viva-voce 10 Marks

Mid Semester Assessment (Attendence-2, Seminars -3 and field report-5) 20 Marks

Practical Course

GEOL6.5DCCP306 Lab: Geo-energy Resources, Economic Geology and Mineral Economics

Maximum Marks: 100 (20 Internal Assessment +80 End Semester Exam)

Exam Duration: 3Hrs

Geo-Energy Resources **30 Marks**

1. Distribution of Coal, Petroleum and Atomic minerals in the Indian Map.
2. Diagrams of Oil Traps.
3. Application of geological data for making various Maps.
4. Graphical representation of geological data etc.

Economic Geology & Mineral Economics **30 Marks**

1. Study of economic minerals in hand specimens, their distribution, genesis and uses.
2. Determination of important ore minerals under reflected light.
3. Distribution of important ore forming minerals in the maps of India and Rajasthan

Record **10 Marks**

Viva-voce **10 Marks**

Mid Semester Assessment (Attendence-2, Seminars -3 and field report-5) 20 Marks

General geological tour of two-week, submission of report and viva-voce before examination.

Semester IV

Marking Scheme for External Exams

Theory Papers	Course Nomenclature	Duration	Max. Marks
GEOL6.5AECT400	General Health and Hygiene (Internal Non-CGPA)		
GEOL6.5DCCT401	Environmental Geology and Engineering Geology	3 Hrs.	80
GEOL6.5DCCT402	Hydrogeology	3 Hrs.	80
GEOL6.5DCCT403	Oceanography and Climatotology	3 Hrs.	80
GEOL6.5DCCT404	Mining Geology	3 Hrs.	80
GEOL6.5DCCP405	Lab: Environmental Geology, Engineering Geology and Hydrogeology	3 Hrs.	80
GEOL6.5DCCP406	Lab: Oceanography,Climatotology and Mining Geology	3 Hrs.	80

GEOL6.5DCCT401 ENVIRONMENT GEOLOGY AND ENGINEERING GEOLOGY

Course objectives

- This course aims to develop a holistic understanding about Environmental Geology and Engineering Geology.
- The course will impart the fundamental understanding about Geological considerations for engineering structures

Course Outcome: After learning this course a student will be able to

- Describe the different Environmental pollution.
- Understand the different cycles

Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit -I

Environment: definition and types of environments; Definition and Fundamental concepts of Environmental Geology. Environmental degradation and Pollution with special reference to India. Pollution- types, (Air pollution, Noise pollution, Water pollution) causes, impact and remedial strategies; groundwater pollution and health issues. Wastes: Solid wastes, Hazardous Chemical wastes, Radioactive wastes, Liquid- Semi liquid (sewerage & wastewater) Wastes and their disposal.

Unit- II

Environmental problems - Acid Rain, global warming, greenhouse effect, global climatic change, Desertification and depletion of the ozone layer, Hazardous Earth Processes: - River flooding: Magnitude & Frequency; Relationship with Urbanisation: Nature & extent of hazard: Perception of River flooding. Landslides: Types; Slope stability; Forces on slopes; Factors affecting Landslides- Earth material type, slope & topography, climate & vegetation, water and the time; Causes of LS- real, immediate, External/ internal; Identification, prevention and correction (control) of LS; Snow Avalanche; Subsidence; Perception of LS hazard

Unit –III

Earthquakes: Effects of EQ- primary & secondary; Magnitude, intensity & frequency of EQ; Human impact on EQ- in causing or reducing EQ; EQ Prediction; Adjusments to EQ; Perception to EQ. Volcanoes: Types; Effects of volcanic activity; Prediction of volcanic activity; Adjustment to & Perception of Volcanic Hazard.

Unit –IV

Earth Resources and Environment: Minerals & Population; Resources & Reserves; Geology of Mineral Resources; Minerals from Sea; Environmental Impact of Mineral Development; Recycling Resources.Landscape Evaluation: Land Use Planning Management; Site Selection and Evaluation; Landscape Aesthetics. Environmental impacts of mining activities; the concept of eco-friendly mining; laws governing protection of the environment and control of pollution; environmental impact assessment (EIA). Elements of Environmental Management Plan (EMP), Global environmental problems and international co-operation.

Unit – V

Application of Geology in Civil engineering. Engineering properties of rocks. Rocks as construction material. Importance and stages of geological exploration for important engineering projects. Dams: Terminology, Classification & types of Dams, Problems related to Dams, geology of dam site, Foundation & abutment competency; Reservoirs: Reservoir site, Reservoir problems, geology of Reservoir site; Geological Investigation of Dam & Reservoir. Tunnels: Terminology, Classification of Tunnels; Geologic Parameters & Problems Earth Tunneling; Geologic Parameters & Problems Rock Tunneling.

Suggested Readings:

1. Keller, E.A. – Environmental Geology (CBS)
2. Valdiya K.S. – Environmental Geology.Tata MGH
3. Coates, D.R. – Environmental Geology
4. Flames, P.T. – Environ. Geology, Conservation land use planning and Resource Development.
5. Cooke and Drunkamp – Geomorphology in Environment Pollution.
6. Horn, B. & Scott, M. – Geological Hazards (Springer Verlog)
7. Tank, R.W. – Focus on Environmental Geology (Oxford)
8. Savindra Singh – Environmental Geography. Prayag Pustak Bhawan.

9. Pratap Singh – Sustenable Devel. With Renewawable Energy Resources. (Yash Publi; Bikaner)
10. Abbasi & Abbasi - Renewawable Energy Resources & their Implication. (Prentice Hall India)

GEOL6.5DCCT402 HYDROGEOLOGY

Course objectives

- This course aims to develop a holistic understanding about Hydrogeology.
- The course will impart the fundamental understanding about GW movement, Pollution and Quality.

Course Outcomes

After learning the course, a student will be able to

- Describe the rock hydrological properties to understand the aquifer and its characteristics.
- Carry out hydro geological investigationfor any region and propose watershed development measures.

Marks: 100 (80 Theory + 20 Internal assessment) **Periods: 40**

Course Description

Unit- I

Hydrogeology- Introduction: scope, historical background and utilization of groundwater. Hydrological cycle. Sources of groundwater; Rock properties affecting groundwater; Porosity and Permeability. Vertical distribution of groundwater; Aquifers and their types. Groundwater Basins.

Unit -II

Groundwater movement. Darcy's law. Coefficient of permeability. Measurement of permeability. Tracing groundwater movement and dating; flow lines. Water wells: their types and construction methods; collector wells and infiltration galleries. Groundwater level fluctuation. Hydrogeologic characteristics of common types of rocks.

Unit- III

Ground water quality: Measures of water quality; physical, chemical & bacteriological analysis; water quality criteria for drinking, irrigation & industrial purposes. Groundwater Pollution and Restoration; collection of water samples, analysis of groundwater.

Unit- IV

Groundwater monitoring, Basin wide groundwater development: Safe yield & overdraft. Equations of hydrologic equilibrium. Data collection for basin investigation; method of computing safe yield; variability of safe yield. Conjunctive use of surface & grounwater Reservoirs. GW Modeling.

Unit- V

Grounwater Exploration: Geologic and hydrogeologic methods; Geophysical exploration; Test drilling. Hydrogeologic and geophysical well logging. Artificial recharge: need and benefits, methods of artificial recharge: induced recharge, recharge well method, recharge through pits and shafts. Sewage and wastewater recharge; subsurface dams; recharge wells for storm drainage. G.W. Development & Potentials in India. G.W. Potentials of Rajasthan.

Suggested Readings:

1. Todd D. K. : Groundwater hydrology
2. Sanjay Akhuri: Fundamentals of Hydrogeology
3. Fetter: Applied Hydrogeology
4. Nandipati Subba Rao: Hydrogeology Problems with Solutions
5. Karanth: Groundwater assessment and management.

GEOL6.5DCCT403 OCEANOGRAPHY AND CLIMATOLOGY

Course objectives

- This course aims to develop a holistic understanding about Oceanography and Climatology.
- The course will impart the fundamental understanding about Coastal Processes.

Course Outcomes

After learning the course, a student will be able to

- Describe the coastal Geology and oceans.
- To learn concept of climatology and climate change.

Marks: Marks: 100 (80 Theory + 20 Internal assessment)

Course Description **Periods: 40**

Unit- I

Physical properties of seawater: Temperature, Salinity and Density and their distributions. Transparency of seawater, Sound in the sea, Light in the sea, Colour of seawater, Sea Ice. Waves and tides: wave parameters, deep water waves, transformation of waves in shallow water, wave generation. Types of tides, tide producing forces, tidal theories.

Unit-II

Ocean circulation: wind induced currents, Up welling, sinking; equatorial current system, west ward intensification of currents, warm and cold currents of major world ocean, seasonal currents in North Indian Ocean, Thermohaline circulation. Water masses: T-S diagram, Characteristics of water masses, Deep circulation water masses, Major water masses of the world oceans.

Unit- III

Marine geology: Continental shelf, Slope, Shelf sediments, mineral resources of the world ocean, submarine topography, mid oceanic ridge system. Manganese and other deposits and the factors controlling their distribution. Marine biology: Classification of marine environment, Bio geo chemical cycles. Influence of Physical parameters (Temperature, salinity, waves, currents, tides etc.). Mangroves

Unit-IV

Coastal processes – transformation of waves in shallow water – refraction, diffraction, reflection. Coastal and near shore circulation-long shore currents, rip currents and tidal currents. Sediment transport rate – onshore and offshore transport – coastal features – LEO observation, Sea level changes: Periodic Sea level changes – short term variations – long term changes – Impact of global warming on sea level – impacts of sea level rise. Strom surge and tsunamis. Beach features: Beach cycles, beach profiles-erosion and accretion, beach stability – artificial nourishment – coastal defence structures – planning and design of coastal structures – tidal inlets and Lakes, deltas.

Unit-V

Fundamental principles of climatology. Earth‟s radiation balance; latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity, cloud formation and precipitation, water balance. Air masses, monsoon, Jet streams, tropical cyclones, and ENSO. Classification of climates – Koppen‟s and Thornthwaite‟s scheme of classification. Climate change.

Suggested Readings:

1. Introduction to Physical oceanography by M.P.M. Reddy.
2. Introduction to Physical oceanography by Robert. H. Stewart.
3. Introduction to dynamical oceanography by S. Pond and G.L. Pickard.
4. Oceans by Sverdrup, Johnson and Flemming.
5. Coastal and Estuarine Dynamics by A.T. Ippen
6. Estuaries: A Physical Introduction by K.R. Dyer
7. Coastal Engineering by Kiyoshi Horikawa

GEOL6.5DCCT404 MINING GEOLOGY

Course objectives

- This course aims to develop a holistic understanding about different mining methods.
- It will also help the student in understanding the processes of ore beneficiation, Principles & Methods of Mineral dressing.

Course Outcome:

After learning this course a student will be able to

- Describe the different types of Mining
- Understand the sampling and ore dressing.

Marks: 100 (80 Theory + 20 Internal assessment **Periods: 40**

Course Description

Unit- I

Elements of Mining: Classification of mining methods. Methods of breaking rocks. Explosives and blasting. Mining Methods: Placer mining methods, open pit methods, their advantages and disadvantages.

Unit -II

Underground mining methods, Coal Mining methods and Ocean bottom mining methods; their advantages and disadvantages. Ventilation in underground mining: Purpose, types and arrangements of ventilation in underground mining. Mining hazards and safety measures.

Unit- III

Mineral Dressing and its importance, low grade ores and their beneficiation; Ore-microscopy and its contribution to ore-dressing techniques. Aggregate properties of minerals and rocks and their consideration in ore dressing techniques. Principles & Methods of Mineral dressing: approach; prepration; Phases of mineral processing: hand picking, crushing, grinding, sizing, classification, air sizing, blending, concentration, washing, methods. Role of Bacteria in Beneficiation of coal and low-grade ores.

Unit- IV

Methods of separation: gravity separation, magnetic separation, electrostatic separation – jigging, tabling, vanners and miscellaneous floatations. Flotation; reagents; Collectors; Frothers; Modifiers; Agglomeration; miscellaneous processes- amalgamation, thickening, filtration, dewatering, drying.

Unit- V

Dressing of Indian Metallic and non-metallic ores, Beach Sand & coal. Flow sheets for Chromite, Gold, Copper, Lead, Zinc, Manganese, Gypsum, Clay and Coal. Introduction to mineral information system.

Suggested Readings:

1. Singh & Sahni – Advanced Surveying (IBH)
2. Krynine & Judd – Principles of Engineering Geology and Geotectonics (McGraw Hill)
3. Parbin Singh – Engineering and General Geology
4. Sathya Narayan swami, B.S. – Engineering Geology (Dhanpat Rai & Co.)
5. Blyth – Geology of Engineers (ELBS)
6. Arogyaswami, R.N.P. – Courses in mining Geology (oxford & IBH)

M.Sc. Semester IV Practicals

Practical Course

GEOL6.5DCCP405 Lab: Environmental Geology, Engineering Geology and Hydrogeology

Maximum Marks: 100 (20 Internal Assessment +80 End Semester Exam

Exam Duration: 3Hrs

Environmental Geology and Engineerinng Geology 30 Marks

1. Diagrammatic representation of Geologic cycles-tectonic, hydrological, rock & geochemical cycles.
2. Laboratory problems related to environmental geology.
3. Application of geological data for environmental purposes.
4. Graphical representation of geo-environmental data etc Dams, tunnel, reservoirs

Hydrogeology 30 Marks

1. Preparation and study of water table maps, depth to water maps & fluctuation maps.
2. Study of hydrological properties of rocks.
3. Study of ground water quality & Preparation and study of ground water quality maps. Representation of groundwater analyses. Analyses data plots

Record 10 Marks

Viva-Voce 10 Marks

Mid Semester Assessment (Attendence-4, Seminars -6 and Field report- 10) 20 Marks

Practical Course

GEOL6.5DCCP406 Lab: Oceanography,Climatotology and Mining Geology

Maximum Marks: 100 (20 Internal Assessment +80 End Semester Exam)

Exam Duration: 3Hrs

Oceanography and Climatology **30 Marks**

1. Determination of Density using temperature and salinity.

2. Determination of Specific volume anomaly using S, T and D.

3. Stability and Richardson number. 30 Marks

4. Analysis of temperature data (a) Vertical profiles (b) Horizontal profiles (c) Identification of Upwelling and sinking

5. Determination of Heat budget parameters. (a) Latent heat (b) Sensible heat (c) Evaporation

Mining Geology **30 Marks**

Diagrammatic representation of mining methods.

Study of flow sheet for ore beneficiation.

Diagrammatic representation of exploration equipments and machines.

Lab calculation related to mining.

Survey with Prismatic compass, Plane table, Theodolite.

Record **10 Marks**

Viva-Voce **10 Marks**

Mid Semester Assessment (Attendence-4, Seminars -6 and Field report- 10) 20 Marks

Mining training camp of one week duration and Submission of report and Viva-voce before examination.