CURRICULUM

and

SYLLABUS OF COURSES

(w.e.f. ACADEMIC SESSION 2023-2024)

for

- One Year Undergraduate Certificate in Geology,
- Two-Years Undergraduate Diploma in Geology,
- Three-Years B.Sc. (Hons.) in Geology,
- Four-Years B.Sc. (Hons.) with Research in Geology

[Exit Options after completion of 01 Year, 02 Years, 03 Years and 04 Years]

DEPARTMENT OF GEOLOGY,

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PROGRAM OBJECTIVES

1. To impart the fundamental and applied understanding of Geology that will help students to develop rationality in this field towards industry, academia, and research domain.
2. To prepare students for higher studies in Geology and relevant areas.

PROGRAM OUTCOMES

1. Students will have basic and applied understanding of different aspects of Geology.
2. Students will be able to seek new knowledge, skills and manage relevant information from various sources.
3. Students will be trained to work effectively and safely in the field & laboratory environment independently as well as in groups.
4. Students will be able to clearly communicate the results of scientific work in oral, & written formats to both science community and society.
5. Students will be able to learn and act with integrity and good ethics in their profession and their obligation to society.
6. Students will be able to demonstrate knowledge and skills in analysing and identifying entrepreneur opportunities.

ABBREVIATIONS

DSC: Discipline Specific Core

DSE: Discipline Specific Elective

GE: Generic Elective

SEC: Skill Enhancement Course

AEC: Ability Enhancement Course

VAC: Value Added Course

COURSE STRUCTURE

FIRST SEMESTER

Course Type	Course Code	Course Title	L	P	C
DSC	GEC-101	Earth System Science	3	1	4
DSC	GEC-102	Earth Surface Processes	3	1	4
DSC	GEC-103	Mineralogy & Crystallography	3	1	4
*GE or *DSE		Choose from the pool of courses			4
*SEC		Choose one from the pool of courses			2
*AEC or *VAC		Choose one from the pool of courses			2
*AEC or*VAC		Choose one from the pool of courses			2
Total Credits=					**22**

SECOND SEMESTER

Course Type	Course Code	Course Title	L	P	C
DSC	GEC-151	Igneous Petrology	3	1	4
DSC	GEC-152	Sedimentology	3	1	4
DSC	GEC-153	Metamorphic Petrology	3	1	4
*GE or *DSE		Choose from the pool of courses			4
*SEC		Geological Field work			2
*AEC or *VAC		Choose one from the pool of courses			2
*AEC or*VAC		Choose one from the pool of courses			2
Total Credits=					**22**

THIRD SEMESTER

Course Type	Course Code	Course Title	L	P	C
DSC	GEC-201	Hydrogeology	3	1	4
DSC	GEC-202	Structural Geology	3	1	4
DSC	GEC-203	Geochemistry	3	1	4
*GE or *DSE		Choose from the pool of courses			4
*SEC		Choose one from the pool of courses			2
*AEC or *VAC		Choose one from the pool of courses			2
*AEC or*VAC		Choose one from the pool of courses			2
Total Credits=					**22**

FOURTH SEMESTER

Course Type	Course Code	Course Title	L	P	C
DSC	GEC-251	Environmental Geology & Natural Hazards	3	1	4
DSC	GEC-252	Paleontology	3	1	4
DSC	GEC-253	Stratigraphy	3	1	4
*GE or *DSE		Choose from the pool of courses			4
*SEC		Geological Field work			2
*AEC or *VAC		Choose one from the pool of courses			2
*AEC or*VAC		Choose one from the pool of courses			2
Total Credits=					**22**

FIFTH SEMESTER

Course Type	Course Code	Course Title	L	P	C
DSC	GEC-301	Engineering Geology	3	1	4
DSC	GEC-302	Geodynamics	3	1	4
DSC	GEC-303	Oceanography & Climatology	3	1	4
*GE or *DSE		Choose from the pool of courses			4
*GE or *DSE		Choose one from the pool of courses			4
*SEC		Internship / Apprenticeship /Project / Community Outreach			2
Total Credits=					**22**

SIXTH SEMESTER

Course Type	Course Code	Course Title	L	P	C
DSC	GEC-351	Economic Geology	3	1	4
DSC	GEC-352	Application of Remote Sensing & GIS in Geology	3	1	4
DSC	GEC-353	Glaciology	3	1	4
*GE or *DSE		Choose from the pool of courses			4
*SEC		Geological Field work			2
*AEC or*VAC		Choose one from the pool of courses			2
*SEC		Internship / Apprenticeship /Project / Community Outreach			2
Total Credits=					**22**

SEVENTH SEMESTER

Course Type	Course Code	Course Title	L	P	C
DSC	GEC-401	Exploration Geology	3	1	4
*GE or *DSE		Choose one from the pool of courses	3	1	4
*GE or *DSE		Choose one from the pool of courses	3	1	4
*GE or *DSE		Choose from the pool of courses			4
*SEC		Dissertation			6
Total Credits=					**22**

EIGHTH SEMESTER

Course Type	Course Code	Course Title	L	P	C
DSC	GEC-451	Changing climate: past, present & future implications in context of geoscience	3	1	4
*GE or *DSE		Choose one from the pool of courses	3	1	4
*GE or *DSE		Choose one from the pool of courses	3	1	4
*GE or *DSE		Choose from the pool of courses			4
*SEC		Dissertation			6
Total Credits=					**22**

GUIDELINES

Academic credit framework:

A credit is a unit by which the course work is measured. It determines the number of hours of instruction required per week for the duration of a semester (15-16 weeks). One credit is equivalent to 15 hour of teaching (lecture or tutorial) or 30 hours of practical or field work or community engagement and service per semester. Credit is awarded to a learner in recognition of the verified achievement of the defined learning outcomes. One credit involves 30 hours of out-of-class activities such as preparation for classes/lessons, completing assignments which form a part of the course work, and independent reading and study per semester and 15 hours of out-of-class activities per semester for practicum.

Semester/Credits:

1. A semester consists of 90 working days and an academic year is divided into two semesters. Each working week will have 40 hours of instructional time.
2. Internship / apprenticeship can be carried out during the summer term, especially for student who exit after two semesters or four semesters of study.

Different types of courses:

The following types of courses/activities constitute the programmes of study. Each of them will require specific number of hours of teaching/guidance and laboratory/studio/workshop activities, field-based learning/projects, and internships.

1. **Taught courses**: Courses involving lectures relating to a discipline by an expert. A minimum of 15 hours of teaching per credit in a semester. The total learner engaged time for a one credit taught course would be 45 hours.
2. **Seminar**: A course requiring students to participate in structured discussion/conversation or debate focused on assigned tasks/readings. A minimum of 15 hours of participation in seminar activity per credit in a semester.
3. **Practicum (or practical)/Laboratory work**: A course requiring students to participate in an approved project or practical activity that applies previously learned/studied principles/theory related to the chosen field of learning.
4. **Internship**: A course requiring students to participate in professional employment-related activity or work experience, or cooperative education activity with an entity external to the education institution, normally under the supervision of an employee of the given external entity.
5. **Field practice/projects**: Courses requiring students to participate in field-based learning/project generally under the supervision of an employee of the given external entity.

Level of Programme	**Requirements of the Programme**	
Undergraduate Certificate	Entry requirements	• Certificate obtained after successful completion of Grade 12 or equivalent stage of education. • Admission to the first year of the undergraduate programme will be open to those who have met the entrance requirements, including specified levels of attainment, in the programme admission regulations. Admission will be based on the evaluation of documentary evidence (including the academic record and/or evidence relating to the assessment and validation of prior learning outcomes) of the applicant's ability to pursue an undergraduate programme of study.
	Credit requirements	• The successful completion of the first year (first two semesters) of the undergraduate programme involving credit-hours ranging between 40-44 hours followed by an exit 10- credit skills-enhancement course, including at least 6-credit job-specific internship/apprenticeship that would help the graduates acquire job-ready competencies required to enter the workforce.
Undergraduate Diploma	Entry requirements	• Continuation of study or lateral entry in the second year of the undergraduate programme will be possible for those who have met the entrance requirements, including specified levels of attainment, specified in the programme regulations. The continuation of study will be based on the evaluation of documentary evidence (including the academic record and/or evidence relating to the assessment and certification of prior learning) of the applicant's ability to pursue an undergraduate programme of study. • Lateral entry into the programme of study leading to the Undergraduate Diploma will be based on the validation of prior learning outcomes achieved, including those achieved outside of formal learning or through learning and training in the workplace or in the community, or through continuing professional development activities, or through independent/self-directed learning activities.
	Credit requirements	• The successful completion of the first two years (four semesters) of the undergraduate programme involving credit-hours ranging between 80-88 hours followed by an exit 10-credit skills-enhancement course, including at least 6-credit job-specific internship/apprenticeship that would help the graduates acquire job-ready competencies required to enter the workforce.

Bachelor's Degree	Entry requirements	• Continuation of study or lateral entry in the third year (fifth semester) of the undergraduate programme will be possible for those who have met the entrance requirements, including specified levels of attainment, specified in the programme regulations. The continuation of study will be based on the evaluation of documentary evidence (including the academic record and/or evidence relating to the assessment and certification of prior learning) of the applicant's ability to pursue an undergraduate programme of study. • Lateral entry into the programme of study in the fifth semester of the undergraduate programme will be based on the validation of prior learning outcomes achieved, including those achieved outside of formal learning or through learning and training in the workplace or in the community, or through continuing professional development activities, or through independent/self-directed learning activities.
	Credit requirements	• The successful completion of the first three years (six semesters) of the undergraduate programme involving at least a range of 120 -132 credit- hours.
Bachelor's Degree with Hons. /Research	Entry requirements	• An individual seeking admission to the bachelor's degree (Honours/ Research) in a specified field of learning would normally have completed all requirements of the relevant 3-year Bachelor's degree. (After completing requirements of a 3-year bachelor's degree, candidates who meet a minimum CGPA of 7.5* will be allowed to continue studies in the fourth year of the undergraduate programme leading to the bachelor's degree (Research). • Continuation of undergraduate programme leading to the bachelor's degree (Honours/Research) will be open to those who have met the entrance requirements, including specified levels of attainment, in the programme admission regulations. Continuation of the programme of study will be based on the evaluation of documentary evidence (including the academic record and/or evidence relating to the assessment and certification of prior learning) of the applicant's ability to pursue study during the fourth year (semesters 7 & 8) of the 4- year Bachelor's degree (Honours/Research) programme. • Lateral entry into the programme will be based on the validation of prior learning outcomes, including those achieved outside of formal learning or through learning and training in the workplace through continuing professional development activities, or through independent/self-directed/self-managed learning activities.
	Credit requirements	• Successful completion of the 4-year (eight semesters) undergraduate programme involving the range of 160-176 credits, with 40-44 credits at certificate level, 40-44 credits at diploma level, 40-44 credits at degree level, and 40-44 credits at Degree with Hons. /Research level

CATEGORIES OF COURSES:

Every discipline shall offer three categories of courses of study, viz. Discipline Specific Core (DSC) courses, Discipline Specific Electives (DSE) courses and Generic Electives (GE).

Discipline Specific Core (DSC): It represent those courses of Geology (Table 1), which would be pursued by a student as a mandatory requirement of his/her programme. These courses will be appropriately graded and arranged across the semesters of study, being undertaken by the student, with multiple exit options as per NEP 2020.

Table 1
List of Discipline Specific Core (DSC) Courses for B.Sc. Geology (Sem. 1-8)

S.N.	Sem.	Course Code	Subjects	Credits	Exist options			
[1]	1st	GEC-101	Earth System Science	04	Certificate	Diploma	B.Sc. Hons.	B.Sc. Hons. With Research
[2]		GEC-102	Earth Surface Processes	04				
[3]		GEC-103	Mineralogy & Crystallography	04				
[4]	2nd	GEC-151	Igneous Petrology	04				
[5]		GEC-152	Sedimentology	04				
[6]		GEC-153	Metamorphic Petrology	04				
[7]	3rd	GEC-201	Hydrogeology	04				
[8]		GEC-202	Structural Geology	04				
[9]		GEC-203	Geochemistry	04				
[10]	4th	GEC-251	Environmental Geology & Natural Hazards	04				
[11]		GEC-252	Paleontology	04				
[12]		GEC-253	Stratigraphy	04				
[13]	5th	GEC-301	Engineering Geology	04				
[14]		GEC-302	Geodynamics	04				
[15		GEC-303	Oceanography & Climatology	04				
[16]	6th	GEC-351	Economic Geology	04				
[17]		GEC-352	Application of Remote Sensing & GIS in Geology	04				
[18]		GEC-353	Glaciology	04				
[19]	7th	GEC-401	Exploration Geology	04				
[20]	8th	GEC-451	Changing climate: past, present & future implications	04				

The Discipline Specific Elective (DSEs): It represents those courses of Geology for which the students have the liberty to choose in different semesters. Such courses will be available for the students in case of single discipline programme as well as multidisciplinary programme.

Table 2
List of Discipline Specific Elective (DSE) Courses

S.No.	Course Code	Title of Theory Course	Credits
[1]	GEE-101	Rock/Soil Mechanics	04
[2]	GEE-102	Fuel Geology	04
[3]	GEE-103	Himalayan Geology	04
[4]	GEE-104	Seismology	04
[5]	GEE-105	Microwave & InSAR Remote sensing	04
[6]	GEE-106	Natural Disaster Economics	04
[7]	GEE-107	Water-Resource Management	04
[8]	GEE-108	Meteorology	04

Generic Elective (GE) course: It represents those courses, which provide multidisciplinary or interdisciplinary approach in the education. The students will have the liberty to choose such courses in various other disciplines of study (excluding the GEs offered in the parent discipline). The Department would identify or prepare the GE courses and specify them in the framework. In case a student opts for DSEs beyond his/her discipline specific course(s) of study, such DSEs shall be treated as GEs for that student.

Table 3
List of Generic Elective (GE) courses

S.No.	Course Code	Title of Theory Course	Credits
[1]	GEG-101	Natural Disaster Economics	04
[2]	GEG-102	Gemology	04
[3]	GEG-103	Water-Resource Management	04
[4]	GEG-104	Meteorology	04
[5]	GEG-105	Statistical and machine learning techniques	04
[6]	GEG-106	Geo-heritage & Geo-tourism	04

Skill Enhancement Courses (SEC): These are elective and skill-based courses (Table 4) in the field of Geology/Earth science. The students have a liberty to choose such courses from the pool. Objective of such courses is to provide the students with hands-on training, competencies and proficiency and skills. Department may offer some of such courses for the students of all other disciplines too. Such courses may also include Internship/ Apprenticeship/Project/ Community outreach (IAPC).

Table 4
List of Skill Enhancement Courses

S.No.	Course Code	Title of Theory Course	Credits
[1]	GES-101	Geological field work	02
[2]	GES-102	Statistical and machine learning techniques	02
[3]	GES-103	Satellite-based mapping of geological features	02
[4]	GES-104	Microscopic analysis of minerals, rocks and fossils	02
[5]	GES-105	Unmanned Aerial Vehicle (UAV) Mapping	02
[6]	GES-106	Electrical Resistivity Mapping	02

Value Addition Courses (VAC) and Ability Enhancement Courses (AEC): These courses are also elective in nature. Students may choose such courses within the Department if Department offers. Otherwise, the students are at liberty to choose such courses and study them at other departments. The VAC courses are common pool of courses (Table 5) offered by different disciplines and aimed towards personality building; embedding ethical, cultural and constitutional values; promote critical thinking, Indian knowledge systems, scientific temperament, communication skills, creative writing, presentation skills, sports & physical education and teamwork. These courses are meant for all round development of students.

Table 5
List of Value-Added Courses

Course Code	**Course Title**	**L**	**T**	**P**	**C**
DUV101	Universal Human Values and Professional Ethics	1		1	2
DUV102	Yoga and Naturopathy	1		1	2
DUV103	Indian Contribution to Science and Technology	1		1	2
DUV104	Family Culture and National Values	1		1	2
DUV105	Science of Happiness	1		1	2
DUV106	Environmental Communication	1		1	2
DUV107	Stage Acting	1		1	2

AEC courses are the courses (Table 6) based upon the content that leads to knowledge enhancement through various areas of study. They are Language and Literature and Environmental Science and Sustainable Development which will be mandatory for all disciplines

Table 6
List of Ability Enhancement Courses

Course Code	Course Title	L	T	P	C
DUA100	Environmental Studies	2			2
DUA101	English Language	2			2
DUA102	Spanish Language -I	2			2
DUA103	Spanish Language -II	2			2
DUA104	German Language- I	2			2
DUA105	German Language II	2			2
DUA106	French Language I	2			2
DUA107	French Language II	2			2
DUA108	Japanese Language-I	1	1		2
DUA109	Japanese Language-II	1	1		2
DUA110	Chinese Language-I	1	1		2
DUA111	Chinese Language-II	1	1		2

DISSERTATION:

Traditional teaching, usually based on lectures and tutorials, fosters the idea of instruction-driven learning model where students are passive listeners. However, project-based learning as a different learning paradigm is standing behind constructivism learning theory, where learning from real-world situations is put on the first place. Students have a liberty to choose dissertation (04 Credits) as a Discipline Specific Elective (DSE) course at 6^{th} Semester. For the students who want to pursue B.Sc. with Research, it will be compulsory to carry out dissertation at 7^{th} and 8^{th} semesters that will give them 6 credits in 7^{th} & 8^{th} semester, respectively.

Paper - GEC-101
EARTH SYSTEM SCIENCE

Type	**: Core Course**
Total Credits	**: 04 (Theory: 03 + Practical: 01)**
Total Hours	**: 45 Theory + 30 Practical**
Lectures	**: 03 per week**
Practical	**: 01 per week**

THEORY

UNIT-I: Theories of origin of Earth and a brief review of knowledge about the solar system. The Earth in relation to other planets and major surface features of the Earth. The Earth-Moon system.

UNIT-II: The Earth's interior: the nature of the crust-mantle boundary, low velocity zone in the upper mantle, the chemical composition and mineralogy of the Earth's crust, mantle and core, evidence from experimental petrology & study of meteorites, geochemical evolution of the Earth, thermal evolution and state of Earth, continental and oceanic heat flow and convection inmantle.

UNIT-III: Hydrosphere and Atmosphere: Oceanic current systems. Warm and cold ocean currents and their distribution. Impact of ocean currents on climate; Wave erosion and beach processes; Atmospheric circulation; Weather and climatic changes; Earth's heat budget. Soils - processes of formation, soil profile and soil types.

UNIT-IV: Understanding the past from geologic records; Nature of geologic records; Standard Geological time scale and introduction to the concept of time in geological studies; Introduction to geochronological methods and their application in geological studies. History of development in concepts of uniformitarianism, catastrophism and Neptunism.

COURSE OUTCOME:
1. Knowledge about the Earth and its relation to other planets. Importance of Earth science to mankind.
2. Knowledge regarding earth's interior and the dynamic processes of Earth.
3. Detailed knowledge regarding tectonic evolution of the Himalayas and the Indian shield.
4. Significance of geochronology, dating techniques and tectonics.

PRACTICAL
Study of major geomorphic features and their relationships with outcrops through hypsographic models. Detailed study of topographic sheets and preparation of physiographic description of an area

SUGGESTED READINGS:
1. The Solid Earth, Fowler, C.M.R., Cambridge University Press, New York,
2. Understanding Earth, Gauss, I.G., Smith, P.S. and Wilson, R.G.L., MIT Press(1973).
3. The Dynamic earth - A textbook in Geosciences, Wyllie, P.J., Wiley.
4. Physics and Geology,Jacobs,J.J., Russel,R.D. and Wilson, J.T., McGraw Hill.
5. Holmes' principles of physical geology., Taylor & Francis. Duff, P. M. D., & Duff, D. (Eds.). (1993).
6. Oceanography: A view of the earth. Gross, M. G. (1977).

Paper - GEC-102
EARTH SURFACE PROCESSES

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Introduction to Geomorphology, Endogenic and Exogenic processes.

Unit-II: Geoid, Topography, Hypsometry, Global Hypsometry, Major Morphological features Large Scale Topography - Ocean basins, Plate tectonics overview, Large scale mountain ranges (with emphasis on Himalaya).

Unit-III: Surficial Processes and geomorphology, Weathering, erosional and depositional landforms, Hill slopes Glacial, Periglacial processes and landforms, Fluvial processes and landforms, Aeolian Processes and landforms, Coastal Processes and landforms, Landforms associated with igneous activities.

Unit-IV: Endogenic- Exogenic interactions, Rates of uplift and denudation, Tectonics and drainage development, Sea-level change, Long-term landscape development. Overview of Indian Geomorphology, Extra-terrestrial landforms.

PRACTICALS

Reading topographic maps, Concept of scale Preparation of a topographic profile, Preparation of longitudinal profile of a river; Preparing Hack Profile; Calculating Stream length gradient index, Morphometry of a drainage basin, Calculating different morphometric parameters, Preparation of geomorphic map, Interpretation of geomorphic processes from the geomorphology of the area.

COURSE OUTCOME: Geomorphology is an important field of study that deals with the activities of natural surface and subsurface agents engaged in removal of old and formation of new landforms on the earth's surface. It helps in many fields such as ground water exploration and storage, flood control, waste disposal, smart city development, oil and natural gas exploration, infrastructure development, and more. Mastering geomorphology can be beneficial for various competitive exams, including Indian Forest Service, Geography optional in Civil Services, and General Studies paper in Civil Services exams. Students interested in adventure and exploration can find learning in the field of geology fun and exciting.

SUGGESTED READING:

1. Allen, P. A. (2009). Earth surface processes. John Wiley & Sons.
2. Huggett, R., & Shuttleworth, E. (2022). Fundamentals of geomorphology. Taylor & Francis.
3. M.A. Summerfield (1991) Global Geomorphology. Wiley & Sons.
4. Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.

Paper - GEC-103
MINERALOGY & CRYSTALLOGRAPHY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Elementary ideas about crystal morphology in relation to internal structures, Crystal parameters and indices, Crystal symmetry and classification of crystals into six systems and 32-point groups

Unit-II: Crystal symmetry and projections, Elements of crystal chemistry and aspects of crystal structures, Stereographic projections of symmetry elements and forms,

Unit-III: Minerals - definition and classification, physical and chemical properties Composition of common rock-forming minerals, Silicate and non-silicate structures; CCP and HCP structures

Unit-IV: Properties of light and optical microscopy, Nature of light and principles of optical mineralogy, Introduction to the petrological microscope and identification of common rock-forming minerals.

PRACTICALS
Observation and documentation on symmetry of crystals
Study of physical properties of minerals in hand specimen
Study of some key silicate minerals under optical microscope and their characteristic properties

COURSE OUTCOME: Develop an understanding of the chemical nature of earth and other planetary material.

SUGGESTED READINGS:
1. Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
2. Kerr, P. F. (1959). Optical Mineralogy. McGraw-Hill.
3. Verma, P. K. (2010). Optical Mineralogy (Four Colour). Ane Books Pvt Ltd.
4. Deer, W. A., Howie, R. A., & Zussman, J. (1992). An introduction to the rock-forming minerals (Vol. 696). London: Longman.

Paper - GEC-151
IGNEOUS PETROLOGY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Scope of Igneous petrology, classification of Igneous rocks, igneous textures, igneous structures. Magma differentiation, fractional crystallization, assimilation, liquid immiscibility.

Unit-II: Gibbs Phase rule, Study of phase equilibria in binary (Diopside-Anorthite, Forsterite- Silica, Leucite-Silica, Albite- Anorthite, Orthoclase-Anorthite) and ternary silicate systems (Orthoclase-Albite-Silica, Diopsite-Albite-Anorthite, Diopside-Foresterite-Silica, Fayalite-Leucite-Silica)

Unit-III: Texture, Structure and IUGS classification schemes of igneous rocks; Petrogenesis and tectonic setting of major igneous rock types and suites: Ultramafic rocks- komatiite, lamprophyres, kimberlite; Ophiolites, flood basalt, anorthosite, Tonalite-Trondhjemite- Granodiorite (TTG), granitoids, alkaline rocks and carbonatites with special reference to Indian examples.

Unit-IV: Modal mineralogy, normative mineralogy, variation diagrams based on major elements, major element indices of differentiation, identification of differentiation processes using trace elements, application of radioactive isotopes in igneous petrology. Basalts and mantle structure, Oceanic magmatism, Igneous Rocks of Convergent Margins and Igneous Rocks of the Continental Lithosphere.

PRACTICAL

- Study of important igneous rocks in hand specimens and thin sections.
- Calculation of Norm & Classification of Igneous Rocks.
- Plotting and interpretation of variation diagrams.

COURSE OUTCOME: On completion of the course, the student should be able to understand the genesis of igneous rocks using petrographical, mineralogical and geochemical perspectives.

SUGGESTED READINGS:

1. Frost, B. R. and Frost, C. D., (2013) Essentials of Igneous and Metamorphic Petrology Cambridge University Press
2. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
3. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
4. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.

Paper - GEC-152
SEDIMENTOLOGY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Sedimentary Processes: Introduction to basic concepts: Developments in sedimentology, description and classification of sedimentary rocks, sedimentary environments and facies, earth's sedimentary shell. Weathering and sedimentary flux: Physical and chemical weathering, submarine weathering, soils and paleosols.

Unit-II: Fluid flow, sediment transport and sedimentary structures: Types of fluids, Laminar vs. turbulent flow, Reynolds number, Froude Number, Boundary layer effect, Particle entrainment, transport and deposition, sediment gravity flows, Concept of flow regimes and bedforms. Siliciclastic rocks: Sedimentary texture: Grain size scale, particle size distribution, statistical treatment of particle size data, particle shape and fabric.

Unit-III: Sedimentary structure: Primary and secondary sedimentary structures, Paleocurrent analysis. Siliciclastic rocks: Conglomerates, sandstones, mudrocks (texture, composition, classification and origin and occurrence). Diagenetic processes. Introduction to coal and petroleum.

Unit-IV: Nonsiliciclastic rocks: Carbonate rocks, controls of carbonate deposition, components and classification of limestone, dolomite and dolomitisatiion, carbonate sedimentary environments. Chert and siliceous sediments, phosphorites, carbonaceous sediments, iron rich sediments and evaporites. X-ray and DTA analysis of clays, heavy mineral analysis and its significance.

PRACTICAL

Exercises on sedimentary structures Particle size distribution and statistical treatment Palaeo-current analysis Petrography of selected clastic and non-clastic rocks through hand specimens and thin sections.

COURSE OUTCOME: Detailed knowledge of sedimentary rocks, structures, environments of sedimentation and sedimentary facies in nature. Characteristics of various sedimentary environments. Field and laboratory methods to study and analyze sedimentary rocks.

SUGGESTED READINGS:

1. Sedimentary Rocks, Pettijohn, F.J., CBS.
2. Depositional Sedimentary Environments, Reineck and Singh, Springer.
3. Manual of Sedimentary petrography, Krumbein and Pettijohn.
4. Principles of Sedimentary deposits: Stratigraphy and Sedimentology, Friedman, Gerald and Sanders, Macmillan USA.

Paper - GEC-153
METAMORPHIC PETROLOGY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Phase rule and Goldschmidt mineralogical phase rule, pure and impure phases. Definition of metamorphism. Factors controlling metamorphism, Types of metamorphism.

Unit-II: Chemographic projections, concept of compatible and incompatible assemblages and discontinuous reactions, bulk composition influence on metamorphic assemblages. Structure and textures of metamorphic rocks, Relationship between metamorphism and deformation.

Unit-III: Metamorphic zones and isograde. Metamorphic mineral reactions (prograde and retrograde)- exchange vectors and continuous reactions, Metamorphism series- Low P, Intermediate P and high P series.

Unit-IV: Concept of metamorphic facies and grade, Migmatites and their origin Metasomatism and role of fluids in metamorphism, basics of geothermobarometry

PRACTICALS

Plotting the quantitative as well as qualitative mineral and mineral assemblage data to interpret the discontinuous reactions and to infer the nature of continuous reactions.

COURSE OUTCOME: Students will be able to understand the P-T regimes of metamorphic mineral assemblages in different geodynamic settings.

SUGGESTED READINGS:

1. Frost, B. R. and Frost, C. D., (2013) Essentials of Igneous and Metamorphic Petrology Cambridge University Press
2. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
3. Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Earth Science Series.
4. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.

Paper - GEC-201
HYDROGEOLOGY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

UNIT-I: Introduction to hydrogeology, hydrologic cycle, water budget on earth, water balance studies, origin of groundwater, springs, their classification and characteristics, quality of groundwater, drinking water criteria, standards of industrial and agricultural use of water.

UNIT-II: Hydrological properties of water bearing materials, porosity, void ratio, permeability, transmissivity, storability, specific yield, specific retention, diffusivity, and field and laboratory methods of determination of permeability. Movement of groundwater and aquifer performance tests. Darcy law and its range of validity. Theory of groundwater flow under steady and unsteady conditions, determination of permeability, transmissivity and storability by discharging well methods.

UNIT-III: Mode of occurrence of ground water, classification of rocks with respect to their water bearing characteristics, aquifers, aquicludes, aquitards, aquifuge, classification of aquifers, photo-geological and remote sensing studies for water resources evaluation, groundwater exploration, water well drilling, development of wells, groundwater management, hydrograph analysis, conjunctive and consumptive use of groundwater and hydrograph analysis.

UNIT-IV: Physical properties used for groundwater exploration, groundwater exploration methods, resistivity method, concept of apparent and true resistivity, profiling and sounding, range of resistivity values for various rocks and minerals and application of seismic refraction method for groundwater problems.

PRACTICAL

Preparation and interpretation of water table contour map and depth of water table maps. Chemical quality maps, hydrographic maps, analytical instruments and their uses, interpretation of hydro-geochemical data, evaluation of hydrological parameters of aquifers, processing and interpretation of pumping test data. Numerical and graphical exercises.

COURSE OUTCOME: Basic knowledge of geohydrology and groundwater prospecting techniques. knowledge regarding groundwater flow under steady and unsteady conditions Knowledge regarding groundwater exploration and management. Application of seismic refraction methods in groundwater problems.

SUGGESTED READING:

1. A text book of Geomorphology, Worcester, P.G., East West Press.
2. Ground water Hydrology, David K. Todd., John Wiley and Sons.
3. Principle of Hydrology, Ward, R.C. and Robinson, M., Tata McGraw Hill.
4. HandBook of applied Hydrology, Chow, V.T., McGraw Hill.
5. Introduction to groundwater hydrology, Heath, R.C. and Trainer, F.W., John Wiley and Sons.
6. Hydrology,Meinzer, O.E., Dover

Paper - GEC-202
STRUCTURAL GEOLOGY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

UNIT-I: Mechanical principles and properties of rocks and their controlling factors. Theory of rock failure. Concept of stress and strain and their relationships of elastic, plastic and viscous materials. Strain markers in naturally deformed rocks. Behavior of minerals and rocks under deformation conditions.

UNIT-II: Fold: mechanics of folding and buckling. Fractures and joints: their nomenclature, age relationship, origin and significance. Causes and dynamics of faulting, strike-slip faults, normal faults, over thrust and nappe. Planar and linear fabrics in deformed rocks, their origin and significance. Structural behavior of diapirs and salt domes.

UNIT-III: Concept of petro-fabrics and symmetry: objective, field and laboratory techniques and types of fabrics. Time relationship between crystallization and deformation.

UNIT-IV: Major tectonic division of Himalaya, collision of India with Asia, evolution of volcanic island arc, Indus- suture zone, emergence and evolution of Himalaya, orogeny, fore arc basin and back arc basin. Study of stereographic projection.

PRACTICAL

Preparation and interpretation of geological map and section. Structural problems concerning economic mineral deposits. Recording and plotting of field data. Plotting and interpretation of petro-fabric data and resultant diagrams. Study of large-scale tectonic features of the earth.

COURSE OUTCOME: Students will gain the practical knowledge about the subject and will be able to apply it in the field in geo-scientific projects professionally.

SUGGESTED READING:

1. Folding and fracturing of rocks, 1967, Ramsay, J.G., McGraw Hill.
2. An outline of Structural Geology, Hobbs, B.E., Means, W.D. and Williams, P.F., John Wiley.
3. Structural Geology of rocks and region, Davis, G.R., 1984. JohnWiley.
4. Modern Structural Geology, Volume I & II, 1987, Ramsay, J.G. and Hubber, M.I., Academic Press.
5. Analysis of geological structures, Price, N.J. and Cosgrove, J.W., 1990, Cambridge Univ. Press.
6. Structural Geology fundamentals of modern developments, Ghosh, S.K., 1995, Pregamon Press.
7. Global tectonics, 1990 Keary, P. and Vine, F.J., Blackwell.

Paper - GEC-203
GEOCHEMISTRY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Introduction to properties of elements: The periodic table, Chemical bonding, states of matter and atomic environment of elements, geochemical classification of elements.

Unit-II: Origin of chemical elements and stellar evolution. Meteorites, distribution of elements in core, mantle, crust.

Unit-III: Geochemical variability of magma and its products. Near surface geochemical environment: Eh-pH diagram; Chemical weathering of minerals and rocks.

Unit-IV: Stable & radioactive isotopes: character and applications.

PRACTICALS

Geochemical data analysis and interpretation of common geochemical plots.

COURSE OUTCOME: Develop an understanding of the chemical nature of earth and other planetary material.

SUGGESTED READINGS:

1. Albarede, F, 2003. An introduction to geochemistry. Cambridge University Press.
2. Dickin' A. P., 1995,Rdiogenic Isotope Geology, Cambridgy UniversityPress
3. Walther John, V., 2009 Essentials of geochemistry, student edition. Jones and Bartlett Publishers

Paper - GEC-251
ENVIRONMENTAL GEOLOGY & NATURAL HAZARDS

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

UNIT-I: Components of environment, ecology and ecosystem. Interactions between atmosphere, hydrosphere, lithosphere, biosphere and man. Principles of environmental Geology, ethics of conservation. Atmosphere and increasing trend of CO_2 and other greenhouse gases. Fossil fuel burning, ozone layer and global warming. Smog pollution and acid rains, causes and remedies. Other causes of pollution.

UNIT -II: Introduction to hazards: Hazards' classification and distribution, Natural Hazards and their effects, hazard prediction and early warning, role of community and stakeholders. Earthquakes: classification, distribution, causes and effects. Tsunami: Types, effects, prediction and early warning systems.

UNIT-III: Land degradation due to natural hazards. Land conservation and land use planning. Watershed management. Impact of irrigation - water logging and soil degradation. Energy minerals and their conservation, nonconventional sources of energy. Environmental impact assessment and knowledge of environmental. Nuclear waste disposal and geological constraints.

UNIT IV: Landslides: classification, distribution, causes, effects and prevention/mitigation of landslides. Volcanic hazards: Types, distribution, causes and effects of volcanoes and related hazards. Floods: Types and factors leading to floods, flood control/mitigation measures. Cyclones, thunderstorms and lightning, prediction and early warning, droughts and desertification.

COURSE OUTCOME: After completion of the course the students will get to know about the types and causes of natural hazards and their related consequences. The course also provides understanding about various mitigation measures that can be taken during such hazard situations.

Suggested Readings:

1. Environmental geology, Lindgren, L., Prentice Hall.
2. Environmental geology, Keller, E.A., Pearson.
3. Environmental Geoscience: Interaction between natural systems and man, Strahler, A.N. and Strahler, A.H., John Wiley And Sons Inc.
4. A text book of environmental chemistry and pollution control, Dara, S.S. and Mishra, D.D., S. Chand and Company.
5. Water pollution, Tripathi, A.K. and Panday, S.N., CBS
6. Natural Disasters, Patrick Leon Abbott., McGraw-Hill Education.
7. Disasters Guidelines, NIDM. 3. Disasters Guidelines, NDMA.
8. Citizens Guide to Disaster Management: How to Save Your Own Life & Help Others, Satish Modh, Laxmi Publication.

PRACTICAL

Preparation of ecological maps and their interpretation. Evaluation of water quality criteria for potable, domestic, industrial, irrigation and waste water. Evaluation of environmental impact of air pollution, groundwater pollution, soil and land degradation, landslides, Earthquake, deforestation, cultivation and urbanization in specified areas

Paper – GEC-252
PALEONTOLOGY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Fossilization processes and modes of preservation, Species concept with special reference to paleontology, Taxonomic hierarchy Theory of organic evolution interpreted from fossil record

Unit-II: Brief introduction to important invertebrate groups (Bivalvia, Gastropoda, Brachiopoda) and their biostratigraphy significance, Significance of ammonites in Mesozoic biostratigraphy and their paleobiogeographic implications, Functional adaptation in trilobites and ammonoids

Unit-III: Origin of vertebrates and major steps in vertebrate evolution, Mesozoic reptiles with special reference to origin diversity and extinction of dinosaurs, Evolution of horse and intercontinental migrations, Human evolution

Unit-IV: Introduction to Palaeobotany, Gondwana Flora, Introduction to Ichnology, Application of fossils in Stratigraphy, Biozones, index fossils, correlation, Role of fossils in sequence stratigraphy, Fossils and paleoenvironmental analysis, Fossils and paleobiogeography, biogeographic provinces, dispersals and barriers, Paleoecology

PRACTICALS
Study of fossils showing various modes of preservation. Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils

COURSE OUTCOME: This course will provide a deep understanding of the history of life on Earth, as well as the scientific methods used to study and interpret the fossil record.

SUGGESTED READINGS

1. Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Paleontology.
2. Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing.
3. Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons.
4. Shukla, A. C., & Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher

Paper - GEC-253
STRATIGRAPHY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Principles of stratigraphy; Fundamentals of litho-, bio- and chrono-stratigraphy, Introduction to concepts of dynamic stratigraphy (chemostratigraphy, seismic stratigraphy, sequence stratigraphy). Code of stratigraphic nomenclature, International Stratigraphic Code – development of a standardized stratigraphic nomenclature. Concepts of Stratotypes. Global Stratotype Section and Point (GSSP). Brief introduction to the concepts of lithostratigraphy, biostratigraphy, chronostratigraphy, seismic stratigraphy, chemostratigraphy, Magnetostratigraphy, Sequence stratigraphy and their subdivisions with Indian examples

Unit-II: Principles of stratigraphic analysis Facies concept in stratigraphy, Walther's Law of Facies. Concept of paleogeographic reconstruction, Physiographic and tectonic subdivisions of India, Brief introduction to the physiographic and tectonic subdivisions of India. Introduction to Indian Shield, Introduction to Proterozoic basins of India. Geology of Vindhyan and Cudappah basins of India.Phanerozoic Stratigraphy of India

Unit-III: Paleozoic Succession of Kashmir and its correlatives from Spiti and Zanskar Stratigraphy, Structure and hydrocarbon potential of Gondwana basins.
Mesozoic stratigraphy of India, Cenozoic stratigraphy of India, Stratigraphy and structure of Krishna-Godavari basin, Cauvery basin, Bombay offshore basin, Kutch and Saurashtra basins and their potential for hydrocarbon exploration.

Unit-IV: Volcanic provinces of India, Stratigraphic boundaries, Important Stratigraphic boundaries in India

PRACTICALS
Study of geological map of India and identification of major stratigraphic units. Study of rocks in hand specimens from known Indian stratigraphic horizons. Drawing various paleogeographic maps of Precambrian time. Study of different Proterozoic supercontinent reconstructions.

COURSE OUTCOME: Students can expect to learn about the different stratigraphic units in India, their correlation with the international geological time scale, and the geological formations and economic resources associated with them.

SUGGESTED READINGS:

1. Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi
2. Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley
3. Ramakrishnan, M. &Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological society of India, Bangalore.
4. Valdiya, K. S. (2010) The making of India, Macmillan India Pvt. Ltd.

Paper - GEC-301
ENGINEERING GEOLOGY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Engineering Geology vs. Geotechnical Engineering. Rock mass classification systems, Soil/Rock Mechanics in Engineering Geology.

Unit-II: Engineering geological investigation of tunnel, DAM, highway, buildings, bridges.

Unit-III: Engineering Geological investigation of natural hazards processes; Landslides, floods, and earthquakes.

Unit-IV: Engineering geology for underground environment with case studies from India and other countries.

PRACTICALS

Rock mass classification calculations. Stress-strain calculations, Soil laboratory experiments, Basic numerical simulations.

COURSE OUTCOME: Students will learn methods of assessing geological perspective of major infrastructure projects. Rock properties related to the strength and bearing capacities of rocks and soils. Understanding the effect and relationship of natural hazards on engineering projects.

SUGGESTED READINGS:

1. Bell, F. G. (2007). Engineering geology. Elsevier.
2. Peng, S., & Zhang, J. (2007). Engineering geology for underground rocks. Springer Science & Business Media.
3. Waltham, T. (2009). Foundations of engineering geology. CRC press.

Paper - GEC-302
GEODYNAMICS

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Lithosphere, Isostasy, Force, Stress and Pressure.

Unit-II: Stress-strain pattern, Types of deformation, Steady and unsteady heat transfer.

Unit III: Importance of different rheological descriptions: brittle, elastic, linear and nonlinear fluids, and viscoelastic.

Unit-IV: Post-seismic deformation, subduction and downwelling, Thermodynamics.

PRACTICALS

Stress-strain calculations, Solving numerical equations.

COURSE OUTCOMES: Students will learn deformation pattern of earth through various perspectives.

SUGGESTED READINGS:

1. Delikaraoglou, D. (1989). On principles, methods and recent advances in studies towards a GPS-based control system for geodesy and geodynamics.
2. Morgan, P. (1983). Principles of Geodynamics.
3. Scheidegger, A. E. (2012). Principles of geodynamics. Springer Science & Business Media.

Paper - GEC-303
OCEANOGRAPHY & CLIMATOLOGY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: General Introduction to Oceanography, Ocean Waves and Tides, Physical & Chemical Properties of Sea Water.

Unit-II: Ocean Currents, Circulation of ocean currents, Global thermohaline circulation, Ocean gateways.

Unit III: Earth atmosphere: Role, Structure & Composition, Pressure & Temperature distribution on Earth & Heat Budget, Temperature Inversion: Types & Effects on Weather

Unit-IV: Atmospheric Pressure Belts and Wind Systems, Subtropical Jet Stream & Polar Jet Stream, Indian Summer Monsoon, Western Disturbance, ENSO, Indian Ocean Dipole (IOD), North Atlantic Oscillation.

PRACTICALS

Graphical exercises to understand climatic regime through oceanographic and climatological proxies.

COURSE OUTCOME: Students will learn basic concepts of Ocean dynamics and its interaction with atmosphere.

SUGGESTED READINGS:

1. Talley, L. D. (2011). Descriptive physical oceanography: an introduction. Academic press.
2. Van Aken, H. M. (2007). The oceanic thermohaline circulation: an introduction (Vol. 326). New York, NY: Springer.
3. Wang, S. Y. S., & Gillies, R. (Eds.). (2012). Modern Climatology.

Paper - GEC-351
ECONOMIC GEOLOGY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Ores, gangue minerals, tenor, grade and lodes, Resources and reserves- Economic and Academic definitions, Mineral occurrence, Mineral deposit and Ore deposit, Historical concepts of ore genesis: Man's earliest vocation- Mining, Plutonist and Neptunist concepts of ore genesis

Unit-II: Exploration and exploitation techniques, Remote Sensing, Geophysical and Geochemical Explorations, Geological mapping at different scales, drilling, borehole logs and transverse sections

Unit-IIII: Concordant and discordant ore bodies, Endogenous processes: Magmatic concentration, skarns, greisen, and hydrothermal deposits Exogenous, processes: weathering products and residual deposits, oxidation and supergene enrichment, placer deposits.

Unit-IV: Ore grade and Reserve, assessment of grade, reserve estimation, Metallic and Non-metallic ores, Metallogenic provinces and epochs, Important deposits of India including atomic minerals, Non-metallic and industrial rocks and minerals, in India. Introduction to gemstones.

PRACTICALS

Study of microscopic properties of ore forming minerals (Oxides and sulphides).
Distribution of important ores and other economic minerals in India.

COURSE OUTCOME: Students will learn about the geological processes behind the formation and extraction of economically valuable minerals, as well as interdisciplinary subjects such as chemistry, physics, geography, and economics.

SUGGESTED READINGS:

1. Guilbert, J.M. and Park Jr., C.F. (1986) The Geology of Ore deposits. Freeman & Co.
2. Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.
3. Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley
4. Laurence Robb. (2005) Introduction to ore forming processes. Wiley.
5. Gokhale, K.V.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.
6. Deb, S. (1980) Industrial minerals and rocks of India. Allied Publishers.
7. Sarkar, S.C. and Gupta, A. (2014) Crustal Evolution and Metallogeny in India. Cambridge Publications.

Paper - GEC-352
APPLICATION OF REMOTE SENSING AND GIS IN GEOLOGY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Types and acquisition of aerial photographs; Scale and resolution; Principles of stereoscopy, relief displacement, vertical exaggeration and distortion, Elements of air photo interpretation, Identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms.

Unit-II: Remote Sensing, Concepts in Remote Sensing, Sensors and scanners, Satellites and their characteristics, Data formats- Raster and Vector.

Unit-III: Digital Image Processing, Image Errors, Rectification and Restoration, FCC, Image Enhancement (Contrast manipulation; Spatial feature manipulation; multi-image manipulation Filtering), Image Rationing, Image classification and accuracy assessment.

Unit-IV: GIS, Datum, Coordinate systems and Projection systems, Spatial data models and data editing, Spatial modelling - DEM, DSM, TIN (Generation of DEM & DSM; Accuracy assessment; Orthorectification; 3D GIS). GPS, Concepts of GPS, Integrating GPS data with GIS, Change detection; SAR Interferometry, Applications in earth system sciences.

PRACTICALS

Aerial Photo interpretation, identification of rocks and various aeolian, glacial, fluvial and marine landforms. Digital Image Processing exercises including analysis of satellite data in different bands and interpretation of various objects on the basis of their spectral signatures Creating a FCC from raw data, Georeferencing. Generating NDVI images and other image ratio and its interpretation Classification of images. DEM analysis: generating slope map, aspect map and drainage network map and its applications, Microwave image processing.

COURSE OUTCOME: Students will learn about the fundamentals of remote sensing and GIS. Including understanding the principles of remote sensing, such as the different types of sensors and platforms used to acquire data, as well as the methods for analysing and interpreting this data using GIS software. They will also learn about specific applications of remote sensing and GIS technology in different fields, such as environmental monitoring, urban planning, agriculture, and disaster management.

SUGGESTED READING:

1. Demers, M.N., 1997. Fundamentals of Geographic Information System, John Wiley & sons. Inc.
2. Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J., 2001. GPS: Theory & Practice, Springer Wien New York.
3. Jensen, J.R., 1996. Introductory Digital Image Processing: A Remote Sensing Perspective, Springer-Verlag.
4. Lillesand, T. M. & Kiefer, R.W., 2007. Remote Sensing and Image Interpretation, Wiley.

Paper - GEC-353
GLACIOLOGY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

Unit-I: Introduction, importance and implication of glaciological studies, Inventory of Himalayan glaciers, Identification system of glaciers. Glacial morphology, glacial deposits and paleo-glaciation, suspended sediment transport. Reconstruction of paleoclimatic history.

Unit-II: Glacier Hydrology, Sources of Glacial Meltwater, Storage of Water in Glaciers, Methods of Studying Glacier Hydrology, Glacier Hydrological Systems, Discharge Fluctuations, Glacial Meltwater Erosion

Unit-III: Mass balance studies; Net balance, Ablation, accumulation and snow density measurements, Relationship of mass balance to climate, Snow melt processes. Ice surface velocity, Contribution of avalanche in glacier health.

Unit-IV: Physics of ice and snow, Mechanics of snow/ice creep. lee crystals, engineering properties of glacial material, glacial hydrochemistry. Application of remote sensing techniques in glaciology, Application of advanced surveying techniques, Global positioning system, Ground penetrating radar.

PRACTICALS
Identification of snow and glacier by remote sensing. Calculation of heat balance equation; Exercise on flow movement/discharge; Meteorological and microclimatic parameters; Suspended sediment transport; Interpretation of glacial morphological maps; Exercise on mass balance.

COURSE OUTCOME

Students can expect to gain a deep understanding of the physical processes of glaciers, their formation, movement, and impact on the environment.

SUGGESTED READINGS:

1. V.F. Petrenko and Robert, W., 1999. Physics of Ice 1st Edition, Kindle Edition
2. MM Bennett and N F Glasser, 2009, Glacial Geology: Ice Sheets and Landforms, Wiley
3. Jon Erickson, 1996: Glacial Geology, Facts on File
4. Peter Martin, Michael E. Brookfield, Steven Sadura, 2001: Principles of Glacial
5. The Global Cryosphere by Roger Berry and Thian Yew Gan Cambridge University Press

Paper - GEC-401
EXPLORATION GEOLOGY

Type : Core Course
Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

UNIT-I: Prospecting and exploration, history of geophysical methods, planning a prospecting Programme, various types of geo-exploration methods, electrical properties of rocks and minerals, a brief outline of various types of electrical methods, quantities measured in electrical methods, wenner and schlumberger methods of resistivity profiling and sounding.

UNIT-II: Magnetic properties of rocks and minerals, determination of rock densities, introduction to gravity and magnetic methods, gravity anomalies, quantities measured in gravity and magnetic prospecting.

UNIT-III: Seismic prospecting and seismology, elementary principles of reflection and refraction methods, quantities measured in seismic methods, two layered reflection and refraction problems, principles of radioactive methods, examples/case histories of application of various geophysical methods for minerals, coal, and oil, groundwater and geotechnical investigations.

UNIT-IV: Geological prospecting criteria and guides to ore search, principles of geochemical and geo-botanical prospecting. Geological, geochemical and geo-botanical exploration for important metallic and non-metallic deposits with Indian examples. Elementary ideas about methods of drilling, core-logging and ore reserve estimation. Examples/case histories of application of geological methods of exploration.

PRACTICAL

Identification of anomaly 2. Concept of weighted average in anomaly detection 3. Geological cross section

COURSE OUTCOME: Students will be able to gain information regarding geo- exploration methods and its usefulness in exploration programme and to society.

SUGGESTED READINGS:

1. Applied Geophysics, Telford, W.M., Geldart, L.P. and Sheriff, R.E., Cambridge University Press.
2. An Introduction to Geophysical Exploration, Kearey, P. Brooks, M. and Hill, I., Blackwell
3. Principles of Applied Geophysics, Parasnis, D.S., Chapman and Hall
4. Introduction to Geophysical Prospecting, Dobrin, M.B. and Savit, C.H., McGraw-Hill.

Paper - GEC-451
CHANGING CLIMATE: PAST, PRESENT & FUTURE IMPLICATIONS

Total Credits : 04 (Theory: 03 + Practical: 01)
Total Hours : 45 Theory + 30 Practical
Lectures : 03 per week
Practical : 01 per week

THEORY

UNIT-I: Introduction to climatic geology, atmosphere, lithosphere and ocean dynamics, paleoclimate

UNIT-II: Status of Himalayan glaciers, glacial lakes, deglaciation, elevation dependent warming

UNIT-III: Antarctica and study of ice sheets global warming, atmospheric aerosols and air pollution

UNIT-IV: Climate variability, modeling, projection limitations, effects of changing climate on anthroposphere

PRACTICAL Identifying pattern in climatic parameters using QGIS, JASP, MATLAB, and other statistical programme.

COURSE OUTCOME: Students will be involved in research-oriented learning subjected to changing climate.

SUGGESTED READINGS:

1. Kump, L.R., Kasting, J.F. and Crane, R.G., The Earth System, 2nd edn. Pearson Prentice Hall, 2004
2. Oerlemans, J., Glaciers and climate change. A.A Balkema , 2001

Paper – GEE-101
SOIL/ROCK MECHANICS

Type : Discipline Specific Elective
Total Credits : 04 (Theory: 03 + Practical: 01)

THEORY

Unit-I: Soil Composition, Index Properties, Soil Classification, Soil Structure: Clay-Water Forces, Interparticle Forces, Fabric

Unit-II: Mohr Circle, Stress Paths, Elastic Stress Distribution, Stress-Strain and Strength behaviour of Sand, Rankine Earth Pressure, Effective Stress Principle, Capillarity, Soil Suction

Unit III: Engineering classification of rocks, rock mass joints, joint pattern, Thermal & hydraulic properties of rock,

Unit-IV: Failure criteria for rock and rock masses, Friction and Shear strength, Deformability of rocks

PRACTICALS

Solution of numerical equations and graphical (MC envelope, GSI chart, GHB criteria) plots.

COURSE OUTCOME: Students will be learning basics of soil and rock characters & response to various internal as well as external phenomena.

SUGGESTED READINGS:

1. Craig, R. F. (2013). Soil mechanics. Springer.
2. Goodman, R. E. (1989). Introduction to rock mechanics (Vol. 2, pp. 221-388). New York: Wiley.
3. Jaeger, J. C., Cook, N. G., & Zimmerman, R. (2009). Fundamentals of rock mechanics. John Wiley & Sons.

Paper - GEE-102
FUEL GEOLOGY

Type : Discipline Specific Elective
Total Credits : 04 (Theory: 03 + Practical: 01)

THEORY

Unit-I: Definition and origin of coal. Sedimentology of coal bearing strata, types of seam discontinuities and structures associated with coal seams. Chemical characteristics of coal.

Unit-II: Concept of 'Lithotype', 'Maceral' and 'Microlithotype'. Classification of macerals and micro lithotypes. Techniques and methods of coal microscopy. Elementary knowledge of the application of reflectance and fluorescence microscopy. Application of coal petrology. Classification of coal in terms of Rank, Grade and Type. classification for coking and non-coking coals. Elementary Idea about coal preparation, characterization of coal for carbonization, gasification-hydrogenation. Coal as a source rock in petroleum generation.

Unit III: Coalbed methane – a new energy resource. Elementary idea about generation of methane in coal beds, coal as a reservoir and coalbed methane exploration. Underground Coal Gasification: definition, concept and development, environmental benefits. Geological and geographical distribution of coal and lignite deposits in India. Coal exploration and estimation of coal reserves. Indian coal reserves and production of coal in India.

Unit-IV: Petroleum – its composition. Origin and migration of petroleum. Reservoir rocks-porosity and permeability. Reservoir traps – 15 structural, stratigraphic and combination traps. Oilfield fluids – water, oil and gas. Methods of prospecting for oil and gas . Onshore and offshore petroliferous basins of India. Oil-shale and shale-oil.

PRACTICALS

Macroscopic characterization of banded coals. Completion of outcrop in the given maps and calculation of coal reserve. Preparation of polished particulate mounts of coal. Microscopic examination of polished particulate mounts (identification of macerals). Proximate analysis of coal. Macroscopic and microscopic study of cores and well cuttings. Calculation of oil reserves.

COURSE OUTCOMES: Students will learn about the genesis, status and future of conventional energy resources.

SUGGESTED READINGS:

1. Isabel Suárez-Ruiz John Crelling. 2008. Isabel Suárez-Ruiz John Crelling. 2008. Applied Coal Petrology: The Role of Petrology in Coal Utilization, Academic Press.
2. Taylor,G.H., Teichmuller, M., Davis, A., Diessel, C.F.K., Littke, R. and Robert P., 1998: Organic Petrology, Gebruder Borntraeger, Stuttgart.
3. Holson, G.D. and Tiratso, E.N., 1985: Introduction to Petroleum Geology. Gulf Publishing, Houston, Texas

Paper – GEE-103
HIMALAYAN GEOLOGY

Type : Discipline Specific Elective
Total Credits : 04 (Theory: 03 + Practical: 01)

THEORY

Unit-I: : Introduction and subdivision of the Himalayas; Geological terrains of Indian Subcontinent. Precambrian-Proterozoic rocks the Himalaya, their sedimentation, metamorphism and igneous activities.

Unit-II: Himalayan province between Cambrian and Permian. Gondwana tectonics and pre- Himalayan palaeogeography.

Unit III: Palaeotectonic, palaeogeography and closure of the Tethys Sea. Cretaceous volcanism and the Himalayan stratigraphy of different tectono-geomorphic units. Collision of India with Asia and the emergence and evolution of the Himalaya, evolution of Himalayan Foreland basin.

Unit-IV: Quaternary development and Holocene-recent tectonic movements and earthquakes in the Himalaya. Himalayan geochronology and tectonics

PRACTICALS

Stratigraphical & structural map interpretation

COURSE OUTCOMES: Students will have basic understanding of Himalayan geological setting.

SUGGESTED READINGS:

1. Gansser, A., 1959. Geology of the Himalayas.
2. Wadia, D., 1973. Geology of India. McGraw Hill Book co.
3. Krishnan, M.S., 1982. Geology of India and Burma, 6th Edition. CBS Publ.
4. Valdiya, K.S, 1980. Geology of the Kumaon Himalayas. WIG Publ.
5. Valdiya, K.S., 1998. Dynamic Himalya.

Paper – GEE-104
SEISMOLOGY

Type : Discipline Specific Elective
Total Credits : 04 (Theory: 03 + Practical: 01)

THEORY

Unit-I: Introduction to Seismology, Seismic waves, its properties and instruments, active vs passive seismology

Unit-II: Type of seismic networks, Earthquake location. Different magnitude scales and magnitude saturation, Intensity scales, Seismic moment and energy, Earthquake source parameters and source mechanisms

Unit III: Induced seismicity, concept of inhomogeneity and anisotropy, types and causes of earthquakes. Seismic ray theory for spherically stratified earth and velocity structure from travel time data, propagation and characteristics of body waves, surface waves, group and phase velocities, different phases of body waves and their applications

Unit-IV: Principle of electromagnetic seismograph, displacement meters, velocity meter, accelerometer and strain meter seismographs, WWSSN stations, seismic arrays for detection of nuclear explosions, wideband seismometer, strong motion seismograph.

PRACTICALS

Familiarization with seismic zone and seismographs. Exercises in coding and decoding. Exercises/Study of earthquake event.

COURSE OUTCOMES: Students will be learning the basics of seismology and earthquake that is one of the most disastrous natural processes of India.

SUGGESTED READINGS:

1. Holton, J. R. (1973). An introduction to dynamic meteorology. American Journal of Physics, 41(5), 752-754.
2. K. E. Bullen and Bruce A. Bolt, 1985. An Introduction to the theory of Seismology.
3. Peter M. Shearer, 1999. Introduction to Seismology.

Paper – GEE-105
MICROWAVE & InSAR REMOTE SENSING

Type : Discipline Specific Elective
Total Credits : 04 (Theory: 03 + Practical: 01)

THEORY

Unit-I: Basics of microwave remote sensing - Fundamentals – EMR-Electromagnetic Spectrum - Microwave Band Designation Microwave interaction with atmospheric constituents, Earth's surface, vegetation, and ocean.

Unit-II: Radar-Real and synthetic aperture radars, - Principles - different platforms and sensors, System parameters, Target parameters, Radar equation measurement and discrimination, Airborne Data products and selection procedure - SEASAT, SIRA, SIRB, ERS, JERS, RADARSAT missions. Radar data processing - Radar grammetry, Image processing.

Unit-III: SAR Interferrometry – Polarimetry- Interpretation of microwave data - Physical mechanism and empirical models for scattering and emission, volume scattering.

Unit-IV: Applications of microwave remote sensing - Geological interpretation of RADAR –sites-default-files, Application in Agriculture -forestry, Hydrology – ice studies – land use mapping and ocean related studies.

PRACTICALS

Image acquiring, processing and interpretation, flood identification and dictation of inundated areas, earthquake movement and land subsidence. Application in cryosphere studies

COURSE OUTCOME: Students shall be able to understand concepts of passive and active microwave system. Gain knowledge in the principles of Microwave image analysis and interpretation and understand the various application domains of microwave satellite data. Analysing applications of microwave in flood, earthquakes, land subsidence etc. will enhance their acquire skills this will in turn provides employability opportunity in space organization.

SUGGESTED READINGS:

1. Thomas M. Lillesand & Ralph W. Keifer, 2000. Remote Sensing and image interpretation (John Wiley & sons, Inc).
2. Jensen, J. R. 1996. Introductory Digital Image Processing: A Remote Sensing Perspective. Prentice Hall, 2nd Edition.

Paper – GEE-106/GEG-101
NATURAL DISASTER ECONOMICS

Type : Discipline Specific Elective & Generic Elective
Total Credits : 04 (Theory: 04)

THEORY

Unit-I: Post-disaster Management: Evacuation, Rehabilitation, Sanitation, Fooding, Medical Care, Role of Radio, Relief and Rehabilitation. Search, Rescue, Evacuation, Refugee Camp Management, Public Health and disease management

Unit-II: Disasters and impact on Poverty, Corporate Social responsibility and disaster, Community and disaster management, essentials of urban risk reduction, Government planning for disaster management

Unit-III: Principles of loss assessment, Market vs. Non-market Effects, The Recovery Period, Sectors Affected

Unit-IV: Case studies of June 2013 Uttarakhand disaster, July 2018 Kerala disaster**,** Feb 2021 Uttarakhand disaster

COURSE OUTCOME: Students shall be able to understand the impacts of disasters, theories of development for understanding the choices that individuals and firms make in selecting residential and business locations, approaches for risk and vulnerability assessment in insurance and disaster planning.

SUGGESTED READINGS:

1. Albala-Bertrand, J. M. (1993). Political economy of large natural disasters: with special reference to developing countries. OUP Catalogue.
2. Botzen, W. W., Deschenes, O., & Sanders, M. (2019). The economic impacts of natural disasters: A review of models and empirical studies. Review of Environmental Economics and Policy.
3. Okuyama, Y. (2003). Economics of natural disasters: A critical review.

Paper – GEE-107/GEG-103
WATER-RESOURCE MANAGEMENT

Type : Discipline Specific Elective & Generic Elective
Total Credits : 04 (Theory: 04)

THEORY

Unit-I: Hydrological Systems: The hydrological cycle as a system, unit hydrograph methods, identification of hydrological systems, simulation of hydrological systems

Unit-II: Groundwater budgeting and assessment, Methods of artificial groundwater recharge, Induced recharge and rain water harvesting, river bank filtration

Unit-III: Planning of Groundwater Development: Water balance, assessment of recharge, utilizable recharge, Indian practices, constraints on groundwater development, feasibility check, Springwater, planning of groundwater development in canal command areas, planning of groundwater development in coastal aquifers

Unit-IV: Watershed development in India, Common Guidelines 2008, Institutional arrangements at National, State, District, Project and Village level, Allocation of funds, case studies; Corporate Social Responsibility (CSR), Watershed management - experiences and challenges; Role of socioeconomic drivers

PRACTICAL

Observation of rainfall, temperature and evaporation, Observation of groundwater levels in observatory, Observation of gauge and discharge in lab/field, Demonstration of hydrological processes using Total Hydrologic Station, Measurement of infiltration rates.

COURSE OUTCOME: Students will have competency in understanding water-resource management, hydrological cycle parameters and soil erosion

SUGGESTED READINGS:

1. Hydrology and theManagement of Watersheds,4th edition.Ames, Iowa:Wiley Blackwell. 2012 Brooks,K.N., P.F.Ffolliott, andJ.A.Magner.
2. Hydrology and watershed services in the Western Ghats, India.". Tata McGraw-Hill, New Delhi. 2006., Krishnaswamy, J., Lele, S., Jayakumar, R.,
3. Soil and Water Conservation Practices", John Wiley & Sons 2003 Frevert, R.K., Schwab, G.O., Edminster, T.W. and Barnes, K.K.
4. Watersheds: Processes, Assessment and Management Paul DeBarry, John Wiley and Sons, New York, NY 2004

Paper – GEE-108/GEG-104
METEOROLOGY

Type : Discipline Specific Elective & Generic Elective
Total Credits : 04 (Theory: 04)

THEORY

Unit-I: Composition and structure of the atmosphere. Evaporation, condensation, fog, cloud, precipitation and thunderstorm. Thermodynamic: Thermodynamic principles, properties of dry and moist air, adiabatic processes, hydrostatic stability and instability, parcel method. Radiation: Solar and terrestrial radiation, definitions, laws of radiation, albedo, greenhouse effect, streamline, trajectories, relation between stream line and trajectories.

Unit-II: Radar Meteorology: Basic radar equation, wavelengths used for detection of cloud, thunderstorm and cyclone, PPI and RHI scopes, meteorological applications of radar, radar echoes, estimation of precipitation, rain water content and upper winds using radar. Principle of Weather Prediction: Short range, medium range and long-range weather prediction, limits of predictability, forecast evaluation.

Unit-III: Monsoons: Monsoon regions in the tropics, causes of monsoon, the Indian summer monsoons, rainfall distribution, elements of the monsoon system, monsoon disturbances, MTC, monsoon variability, onset and advancement of monsoon, withdrawal, fluctuations in monsoon activity, active, weak and break monsoon conditions, intra seasonal and inter-annual variability of summer monsoon.

Unit-IV: General Circulation Features over India during other seasons: Winter seasons, western disturbances, cold waves, fog, Pre-Monsoon Seasons: different convective phenomenon, Norwesters and tropical storms, Post monsoon Season: N.E. Monsoon, tropical storms and their differences with tropical storms of pre monsoon season.

PRACTICAL

Familiarization with meteorological instruments and record surface meteorological observations. Study of surface weather and upper air codes. Exercises in coding and decoding. Exercises in plotting station models

COURSE OUTCOME: Students will have basic understanding of meteorology

SUGGESTED READINGS:

1. Asnani: Tropical Meteorology,Vol. I and II
2. Saucier: Principles of Meteorological Analysis
3. Wiin-Nielson: Compendium of Meteorology, Vol. I, Part 3, Synoptic Meteorology, Geneva, W.M.O. No. 364.

Paper – GEG-102
GEMOLOGY

Type : Generic Elective
Total Credits : 04 (Theory: 04)

THEORY

Unit-I: Descriptions of gemstones, minerals and rocks. Definition of a gem. Natural gems (minerals, rocks, non-minerals, organic materials). Artificial stones (imitations, composites and synthetics).

Unit-II: Formation of minerals & deposits, Allochromatism and idiochromatism, Isomorphism and polymorphism, Hardness and durability, Mohs' scale, Cleavage, Parting, Fracture, Specific gravity and its determination (hydrostatic and heavy liquids)

Unit-III: Nature of crystals, Crystalline and amorphous materials, Polycrystalline materials, Crystal systems, Symmetry, Crystal habit, Twinning

Unit-IV: Techniques employed in Gemmological Laboratories

COURSE OUTCOME: Students will have understanding of a large variety of stones and gems and will gain knowledge on the grading quality, international standards, procedures of polishing and extending into designing, business and importing, amongst others.

SUGGESTED READINGS:

1. Fritsch, E., & Rondeau, B. (2009). Gemology: The developing science of gems. Elements, 5(3), 147-152.
2. Manutchehr-Danai, M. (2005). Dictionary of gems and gemology. Berlin, Heidelberg: Springer Berlin Heidelberg.
3. Rossman, G. R. (2009). The geochemistry of gems and its relevance to gemology: Different traces, different prices. Elements, 5(3), 159-162.

Paper – GEG-105/GES-102
STATISTICAL AND MACHINE LEARNING TECHNIQUES

Type : Generic Elective & Skill Enhancement
Total Credits : 04 (Generic elective) & 2 (Skill enhancement)

THEORY

Unit-I: Introduction to statistical techniques, sampling distributions, probability, confidence intervals, hypothesis testing, regression and correlation

Unit-II: Basic modeling, analysis of variance, and chi-square testing

Unit-III: Introduction to machine learning, machine learning algorithms, neural networks

Unit-IV: Supervised learning, unsupervised learning, semi-supervised learning

PRACTICALS

Excel exercises, JASP exercises, Artificial Neural Network exercises

COURSE OUTCOME: Students will have basic understanding of statistical and machine learning techniques that will help them in any job sector requiring data analysis and pattern recognition.

SUGGESTED READINGS:

1. Bishop, C. M., & Nasrabadi, N. M. (2006). Pattern recognition and machine learning (Vol. 4, No. 4, p. 738). New York: springer.
2. Jung, A. (2022). Machine learning: The basics. Springer Nature.
3. Spatz, C., & Johnston, J. O. (1997). Basic statistics: Tales of distributions. Brooks/Cole Pub.

Paper – GEG-106
GEO-HERITAGE & GEO-TOURISM

Type : Generic Elective
Total Credits : 04 (Generic elective)

THEORY

Unit-I: Geoheritage and public geoliteracy, Definition, characteristics and international/national perspectives of Geo-tourism

Unit-II: Earth Science Museums and their role in promotion of Geotourism

Unit-III: Geotourism and cultural heritage, Examples of Geotourism sites from India, particularly from Himalaya

Unit-IV: The application of geographical information systems in Geotourism, Public–private partnership framework for sustainable geopark development

COURSE OUTCOME: Students will have basic understanding of potential geological sites of tourist interest.

SUGGESTED READINGS:

1. A monograph on National Geoheritage Monuments of India. Indian National Trust for Art and Cultural Heritage (INTACH) Natural Heritage Division, New Delhi (2016).
2. History of Geoconservation, C. V. Burek and C.D. Prosser (Eds.) Special Publication 300, Geological Society of London (2008).
3. National Geological Monuments. Geological Survey of India, Kolkata, Special Publication No.6 1 (2001).

Paper – GES-101
GEOLOGICAL FIELD WORK

Type : Skill Enhancement
Total Credits : 02 for each field semester (II, IV, VI)

FIELD TRAINING

For Semester II: Identification of rocks, minerals in rock samples, and landforms in field, geological mapping

For Semester IV: Identification of structures, structural mapping, collecting water samples from waterbodies for laboratory analysis, Identification of fossils and stratigraphic sequence, field visit to flood/earthquake/landslide affected region

For Semester VI: Rock mass and joint mapping at Tunnel, DAM & along the highway, UAV mapping, RMR and Q index validation, mining site visit, glacier terrain visit

COURSE OUTCOME: Students will have comprehensive understanding of geological features, their genesis, extent, and significance in sustainable development.

SUGGESTED READINGS:

1. Catt, J. A. (1986). Soils and Quaternary geology: a handbook for field scientists. Oxford University Press.
2. Coe, A. L. (Ed.). (2010). Geological field techniques. John Wiley & Sons.
3. Compton, R. R., & Compton, R. R. (1985). Geology in the Field (p. 416). New York: Wiley.
4. Knödel, K., Lange, G., & Voigt, H. J. (2007). Environmental geology: handbook of field methods and case studies. Springer Science & Business Media.

Paper – GES-103
SATELLITE-BASED MAPPING OF GEOLOGICAL FEATURES

Type : Skill Enhancement
Total Credits : 02 (Theory: 01+ Practical:01)

THEORY

Unit-I: Types and acquisition of aerial photographs; Scale and resolution; Principles of stereoscopy, relief displacement, vertical exaggeration and distortion, Elements of air photo interpretation

Unit-II: Concepts in Remote Sensing, Sensors and scanners, Satellites and their characteristics, Data formats- Raster and Vector

Unit-III: Digital Image Processing, Image Errors, Rectification and Restoration, FCC, Image Enhancement

Unit-IV: GIS, Datum, Coordinate systems and Projection systems, Spatial data models and data editing, Spatial modelling - DEM, DSM, TIN

PRACTICALS

Aerial Photo interpretation, Digital Image Processing, Analysis of satellite data in different bands and interpretation of various objects on the basis of their spectral signatures, Creating a FCC from raw data, Registration of satellite data with a toposheet of the area, Enhancing the satellite images, Generating NDVI images and other image ratio and its interpretation, Classification of images.

COURSE OUTCOME: Students will have understanding about specific applications of remote sensing and GIS technology in different fields, such as environmental monitoring, urban planning, agriculture, and disaster management.

SUGGESTED READINGS:

5. Demers, M.N., 1997. Fundamentals of Geographic Information System, John Wiley & sons. Inc.
6. Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J., 2001. GPS: Theory & Practice, Springer Wien New York.
7. Jensen, J.R., 1996. Introductory Digital Image Processing: A Remote Sensing Perspective, Springer- Verlag.

Paper – GES-104
MICROSCOPIC ANALYSIS OF MINERALS, ROCKS AND FOSSILS

Type : Skill Enhancement
Total Credits : 02 (Theory: 01+ Practical:01)

THEORY

Unit-I: Introduction to Microscopic analysis of minerals & rock

Unit-II: Texture & mineral composition properties of rocks under microscope

Unit-III: Introduction to Microscopic analysis of

microfossils

Unit-IV: Types, characteristics, texture, pattern under

microscope

PRACTICALS

Microscopic analysis of microfossils, minerals & rock**s**

COURSE OUTCOME: Students will learn to identify microfossils, minerals in rocks, observing them using images of thin sections viewed under a polarising microscope, and deduce how and in what environments the minerals and rocks were formed.

SUGGESTED READINGS:

1. Fritz-Gaertner, R. (1878). The Microscope as a Means of Examination of Rocks and Fossils. The American Naturalist, 12(1), 13-17.
2. Horowitz, A. S., & Potter, P. E. (2012). Introductory petrography of fossils. Springer Science & Business Media.

Paper – GES-105: Unmanned Aerial Vehicle (UAV) MAPPING

Type : Skill Enhancement
Total Credit: 02 (Theory: 01+ Practical:01)

Unit I: Introduction to the UAVs for Geology

Introduction to UAV technology: Components, types, capabilities, and limitations of UAVs for geological applications. Regulations and safety considerations for UAV operations in India. Introduction to flight planning software for defining flight paths and data collection parameters.

Lab: Familiarization with UAV components, flight planning software tutorial, pre-flight checklist practice.

Unit II: UAV Data Acquisition for Geological Mapping

Principles of aerial photography: Image scale, resolution, and factors affecting image quality. Sensor types for UAV-based geological mapping: RGB, multispectral, and thermal cameras. Planning and executing autonomous flight missions for geological surveys.

Lab: Planning a flight mission using software, setting camera parameters, practicing data collection procedures in a simulated environment.

Unit III: UAV Data Processing for Geology

Introduction to photogrammetry and its application in UAV data processing. Software tools for image processing: Orthomosaic generation, point cloud creation, and basic 3D model reconstruction. Extracting geological information from UAV imagery: Identifying rock types, lineaments, faults, and other geological features.

Lab: Processing UAV imagery using software to generate orthomosaics, point clouds, and 3D models. Practice identifying geological features from processed data.

Unit IV: Applications of UAVs in Geological Mapping

Case studies of successful applications of UAVs in various geological mapping projects. Integration of UAV data with other geological datasets (e.g., field observations, geophysical data) for comprehensive analysis. Exploring advanced UAV applications in geology. LiDAR, and digital elevation models (DEMs).

Lab: Analyze real-world UAV datasets for a specific geological application. Integrate UAV data with other datasets (provided) and prepare a report summarizing the findings

COURSE OUTCOME: Students will learn to Plan and execute safe and efficient UAV flights for data collection. Operate basic image acquisition software for UAVs.

Paper – GES-106: Electrical Resistivity Mapping

Type : Skill Enhancement
Total Credit: 02 (Theory: 01+ Practical:01)

Unit I: Introduction to Electrical Resistivity

Introduction to electrical resistivity methods in geosciences. Fundamental concepts of resistivity: Ohm's Law, resistivity of earth materials. Factors affecting electrical resistivity in geological formations. Advantages and limitations of ER methods.

Lab: Familiarization with ER instruments and accessories. Hands-on practice with different electrode configurations (Wenner, Schlumberger).

Unit II: Data Acquisition in ER Surveys

Principles of data acquisition in ER surveys. Types of ER surveys: profiling, sounding, resistivity imaging. Field procedures for conducting ER surveys (data collection, quality control). Health and safety considerations during field surveys.

Lab: Simulation of ER data acquisition using computer software. Practice exercises on data recording and field documentation.

Unit III: Data Interpretation and Analysis

Methods for analyzing and interpreting ER data (curve fitting, inversion). Geoelectrical models and their correlation with geological formations. Integration of ER data with other geological datasets (geological maps, borehole data). Introduction to geophysical software for ER data processing and visualization.

Lab: Hands-on practice with geophysical software for ER data processing. Exercises on interpreting real ER data from various geological settings.

Unit IV: Applications of ER in Geology

Applications of ER in groundwater exploration: aquifer mapping, salinity assessment. Applications of ER in mineral exploration: sulfide orebody delineation, kimberlite pipe detection. Applications of ER in geohazard assessment: cavity detection, landslide investigation.

Lab: Mini-project: Planning, simulating, and interpreting ER data for a specific geological problem.

COURSE OUTCOME: Students will learn to Plan and conduct basic ER surveys in the field. Analyse and interpret ER data to infer subsurface geological features.