PERIYAR UNIVERSITY

NAAC 'A++' Grade – State University - NIRF Rank 63 - ARIIA Rank 10

SALEM – 636 011, TAMIL NADU

DEPARTMENT OF GEOLOGY

UGC NON-SAP & DST-FIST Sponsored Department

M.Sc., Applied Geology

Choice Based Credit System - CBCS

OBE - SYLLABUS

Effective from the Academic year 2022-2023 onwards and thereafter

PERIYAR UNIVERSITY

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DEPARTMENT OF GEOLOGY
M.Sc., APPLIED GEOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS)
OBE –SYLLABUS
REGULATIONS

I. About the Programme

Periyar University offers M.Sc., Applied Geology programme, under Choice Based Credit System (CBCS). The CBCS enables the students to select choice of subjects as per her /his interest and requirement. Acquiring knowledge in the related discipline is advantageous to the students. The CBCS programme is framed in such a way that to impart more Knowledge in the field of Geological sciences.

Geology is an inter-disciplinary subject which enables to understand the earth processes and its treasures. It incorporates inputs from almost all science disciplines. Geologists are mainly involved in the exploration and extraction of natural resources viz., minerals, rocks, fossil fuel and water. As it is a fast growing area geologists will have to play a vital role in building the nation. They can also engage in geological research, which has immense potential in the current scenario.

II. Program Educational Objectives (PEOs)

PEO1: To demonstrate an understanding of the fundamental principles, concepts in theoretical and practical knowledge of the geological Science.

PEO2: An ability to recognize, evaluate, interpret, and understand issues and opportunities at the frontiers of geological domain.

PEO3: Ability to apply the basic knowledge of geology to real-life problems besides the use of computational and mathematical knowledge and tools.

PEO4: Work ethically and professionally alone and as part of a team, complying with applicable legislation and managing time and other resources efficiently and effectively and manage, execute their geological plans to meet desired goals realistic constraints.

PEO5: Communicate geological information concisely and accurately using written, visual, and verbal means appropriate to the situation.

III. Program Outcomes (POs)

PO1: To develop an in-depth knowledge and skills in qualitative and quantitative research methods through laboratory, field and web modes of learning.

PO2: Recognize the need for sustainable use of earth resources, and value environmental, indigenous and other community perspective on geological activities.

PO3: Apply geological knowledge and critical thinking skills to identify a problem and to describe a strategy for handling.

PO4: Synthesize geological data on arrange of spatial and temporal scales to make interpretations that allow for scientific uncertainty.

PO5: Work effectively and professionally in multidisciplinary teams as a member and a leader and be able to manage and analyze complex ethical issues.

IV. Program Specific Outcomes (PSOs)

PSO1: Learn the essential properties of earth components, including its core, mantle, asthenosphere, lithosphere, cryosphere, hydrosphere, atmosphere and biosphere

PSO2: Demonstrate mastery of the conceptual framework for understanding earth system processes and the development of earth's features over time.

PSO3: Acquiring geologic data in the field, laboratory, satellites and big data from data banks, Analyzing and interpreting the data through application of scientific method.

PSO4: Enable to apply successfully advanced and current concepts and methods of the geosciences to formulate and solve complex geological problems.

PSO5: Apply knowledge and techniques from allied fields, including chemistry, physics, biology, mathematics, and computing, to solve geological problems.

PSO6: Capable of understanding the impact of a geo-engineering solution in global and societal context.

PSO7: Students take-up a geologic problem and utilize theoretical, analytical or experimental approach to solve the problem through their project work. The students will be able to defend their project in an open forum.

V. Eligibility for Admission

A candidate who has passed B.Sc. degree in Applied Geology/ Geology of this university or an examination of any other university accepted by the Syndicate as equivalent thereto shall be permitted to appear and qualify for the M.Sc Applied Geology Degree examinations of this university after a course of two academic years, in the Department of Geology, Periyar University.

VI. Duration of the Programme

The course for the degree of Master of Science in Applied Geology shall consist of two academic years divided into four semesters. Each Semester consists of 90 working days.

VII. Course of Study

M.Sc., Applied Geology
Curriculum and Structure of the Programme

Sl.No	Paper Code	Title of the Paper	Hours	L	T	P	C
I-Semester							
1	22UPAGC01	Applied Geomorphology	72	3	1	0	4
2	22UPAGC02	Structural Geology and Geotectonics	72	3	1	0	4
3	22UPAGC03	Crystallography and Mineralogy	72	3	1	0	4
4	22UPAGC04	Palaeontology	72	3	1	0	4
5	22UPAGE…	Elective I/II	72	3	1	0	4
6	22UPAGP01	Practical –I Structural Geology, Mineralogy and Palaeontology*	90	0	0	4	4
7	--	SWAYAM Course	ONLINE				2
		Total	**450**	**15**	**5**	**4**	**26**
II-Semester							
8	22UPAGC05	Igneous and Metamorphic Petrology	72	3	1	0	4
9	22UPAGC06	Sedimentology and Basin Analysis	72	3	1	0	4
10	22UPAGC07	Stratigraphic Principles and Indian Stratigraphy	72	3	1	0	4
11	22UPAGC08	Geoexploration	72	3	1	0	4
12	22UPAGP02	Practical – II Igneous, Metamorphic and Sedimentary petrology*	72	0	0	4	4
13	22UPAGE…	Elective – III / IV	72	3	1	0	4
14	22UPAGHR01	Human Rights -Duties	36	2	0	0	2
15	22UPAGFT	Geological Mapping and Field Training	0	0	0	0	2
		Total	**468**	**17**	**5**	**4**	**28**
22UPAGIT- INTERNSHIP – During Summer Vacation							
III-Semester							
16	22UPAGC09	Economic Geology and Mineral Economics	72	3	1	0	4
17	22UPAGC10	Applied Micropalaeontology	72	3	1	0	4
18	22UPAGC11	Hydrogeology	72	3	1	0	4
19	22UPAGC12	Remote Sensing and GIS	72	3	1	0	4
20	22UPAGE…	Elective V/VI	72	3	1	0	4
21	22UPAGS…	Supportive Course	72	3	1	0	4
22	22UPAGP03	Practical – III Economic Geology and Micropaleontology*	90	0	0	4	4
23	22UPAGP04	Practical – IV Hydrogeology, Remote Sensing and GIS*	90	0	0	4	4
		Total	**540**	**15**	**5**	**8**	**32**
IV- Semester							
24	22UPAGC13	Mining and Engineering Geology	72	3	1	0	4
25	22UPAGE…	Elective VII/VIII	72	3	1	0	4
26	22UPAGPJ	Project/Dissertation	396	0	0	22	7
27	22UPAGVA	Value Added Courses	--	--	--	--	--
28	2UPAGAO	Add on Courses	--	--	--	--	--
		Total	**540**	**6**	**2**	**22**	**15**
Elective Courses							
1	22UPAGE01	Fuel Geology	72	3	1	0	4
2	22UPAGE02	Analytical and Instrumentation Techniques	72	3	1	0	4
3	22UPAGE03	Advanced Surveying Techniques	72	3	1	0	4
4	22UPAGE04	Meteorology and Climate Change	72	3	1	0	4
5	22UPAGE05	Geo-statistics	72	3	1	0	4
6	22UPAGE06	Geo-heritage and Geo-tourism	72	3	1	0	4
7	22UPAGE07	Environmental Geology and Disaster Management	72	3	1	0	4
8	22UPAGE08	Marine Geology	72	3	1	0	4
Supportive Courses							
1	22UPGS01	Earth and Environment	72	3	1	0	4
2	22UPGS02	Water Resources Management	72	3	1	0	4
3	22UPGS03	Gemmology	72	3	1	0	4
4	22UPGS04	Rainwater Harvesting and Artificial Groundwater Recharge	72	3	1	0	4
5	22UPGS05	Geohazards	72	3	1	0	4
Value Added (VA) Courses (Certificate Course – Extra credits)							

1	22UPAGVA01	Hydrology and Water Management	30	2	0	0	2
2	22UPAGVA02	Environmental Studies and Earth Sciences	30	2	0	0	2
Add on (AO) Courses							
1	22UPAGAO01	Medical Geology	30	2	0	0	2
2	22UPAGAO02	Petroleum Geology	30	2	0	0	2
3	22UPAGAO03	Groundwater exploration	30	2	0	0	2
SWAYAM Courses *(Study Webs of Active Learning for Young Aspiring Minds-SWAYAM)*							
1	22UPAGS01	Mineral Resources: Geology, Exploration, Economics and Environment	-				-
2	22UPAGS02	Introduction to Geographic Information Systems	-				-
3	22UPAGS03	Disaster Management	-				-
4	22UPAGS04	Introduction to Mineral Processing	-				-
5	22UPAGS05	Geology and Soil Mechanics	-				-
6	22UPAGS06	Geomorphic Process: Landforms and Landscapes	-				-
7	22UPAGS07	Global Navigation Satellite Systems and Applications	-				-

1. Human Rights -Duties – Compulsory course for All P.G. Students.
2. UPAG-University Programme Applied Geology, C- Core Course, E – Elective Course & S-Supportive Courses, L – Lecture, T- Tutorial, *P – Practical

Credits for Core Courses	70	Credits for SWAYAM Courses	02
Credits for Elective Courses	16	Credits for Human Rights-Duties	02
Credits for Supportive Courses	04		
Total Credits	94		

VIII. Semester

An academic year consists of two semesters. The Normal semester periods are

- Odd Semester : July to November
- Even Semester: December to April

Each semester has 18 teaching weeks with working hours spread over 5 days a week.

IX. Teaching Methodologies

The classroom teaching would be through conventional lectures and use of power point presentation and field demonstration. The lecture would be such that the student should participate actively in the discussion. The Student seminars would be conducted and scientific discussions would be arranged to improve their communicative skill. In the laboratory, instruction would be given for the experiments/exercise followed by demonstration and finally the students have to do the experiments individually. Periodic tests are conducted for the students, In the case of slow learners; they will be given special attention.

X. Course Components

Core courses

Core courses are compulsory basic subjects in the programme offered by the department. Each core course carries 4 credits. Core courses offered by one department will not be treated as elective by other. Core courses include theory, practical, project work, geological mapping, internship, training, field training and industrial visits. Students can be permitted to carry out project works at reputed institutions and industries.

Elective courses

Elective courses (disciplinary) are offered by the parent department. Each elective course carries 4 credits.

Supportive courses

Supportive courses are aimed at bridging the gap in the curricula and to learn the advancements in other disciplines. The department, in consultation with other departments, will offer supportive courses during I, II & III semesters. Similarly, students from Geology Department will study the supportive course from other department.

Compulsory Course

A course on Human rights-Duties is compulsory in the II semester.

XI. SWAYAM Courses

Massive Open Online Course (MOOC) introduced to the students to help them compare their course content with that of the eminent faculty across the country. MOOC online course is available in the SWAYAM and SWAYAM PRABHA MHRD web portal. All the master level students must enroll and complete two MOOC courses related to their discipline of study.

XII. Field Work/Training

Geological field mapping is included in the second semester and its participation is a mandatory requirement. The training is to be scheduled in a single batch for duration of maximum 15 days. It may be guided by faculty members in any place which is geologically significant region within India. Alternatively, the student may be attached to an organization engaged in geological field work (say Geological survey of India) for imparting training.

XIII. Credits

The quantum of syllabus for various programs in terms of hours of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design. The minimum credit requirement for a two-year Master's programme shall be 90.

XIV. Course weightage

A course carrying one credit for lectures will have instruction of one period per week during the semester. If four hours of lecture are necessary in each week for that course, then 4 credits will be the weighted. Thus, normally in each of the courses, credits will be assigned on the basis of the lectures/ tutorials/ laboratory work and other forms of learning in a 18-week schedule.

XV. Evaluation

Evaluation will be done on a continuous basis during the course work through class test and midterm exams. Evaluation may be done by objective type questions, short answers, essays or a combination of these, but the end semester examination is a written examination.

XVI. Attendance

Every teaching faculty handling a course shall be responsible for the maintenance of the common attendance register being maintained in the department for the candidates who have registered for the course.

The student should earn 75% attendance in the courses of that particular semester failing which, he /she will not be permitted to sit for the End-Semester Examination. The student has to repeat the semester in the next year.

XVII. Examinations

There shall be four examinations, each at the end of the semester. Candidates failing in any subject/ subjects will be permitted to re-appear for subsequent semesters as per University norms.

The practical examinations will be conducted at the end of the first, second and third semester. Candidates failing in any of the practical examination / examinations will be permitted to appear for such failed practical examination/ examinations at corresponding subsequent practical examinations.

XVIII. Scheme of Examination

M.Sc., Applied Geology
Curriculum and Scheme of Examinations

Sl.No	Paper Code	Title of the Paper	Hours	I	E	M	C
I-Semester							
1	22UPAGC01	Applied Geomorphology	4	25	75	100	4
2	22UPAGC02	Structural Geology and Geotectonics	4	25	75	100	4
3	22UPAGC03	Crystallography and Mineralogy	4	25	75	100	4
4	22UPAGC04	Palaeontology	4	25	75	100	4
5	22UPAGE…	Elective I/II	4	25	75	100	4
6	22UPAGP01	Practical –I Structural Geology, Mineralogy and Palaeontology*	4	40	60	100	4
7	--	SWAYAM Course	-				2
II-Semester							
8	22UPAGC05	Igneous and Metamorphic Petrology	4	25	75	100	4
9	22UPAGC06	Sedimentology and Basin Analysis	4	25	75	100	4
10	22UPAGC07	Stratigraphic Principles and Indian Stratigraphy	4	25	75	100	4
11	22UPAGC08	Geoexploration	4	25	75	100	4
12	22UPAGP02	Practical – II Igneous, Metamorphic and Sedimentary petrology*	4	40	60	100	4
13	22UPAGE…	Elective – III / IV	4	25	75	100	4
14	22UPAGHR01	Human Rights -Duties	0	25	75	100	2
15	22UPAGFT	Geological Mapping and Field Training	0	25	75	100	2
III-Semester							
16	22UPAGC09	Economic Geology and Mineral Economics	4	25	75	100	4
17	22UPAGC10	Applied Micropalaeontology	4	25	75	100	4
18	22UPAGC11	Hydrogeology	4	25	75	100	4
19	22UPAGC12	Remote Sensing and GIS	4	25	75	100	4
20	22UPAGE…	Elective V/VI	4	25	75	100	4
21	22UPAGS…	Supportive Course	3	25	75	100	4
22	22UPAGP03	Practical – III Economic Geology and Micropaleontology*	4	40	60	100	4
23	22UPAGP04	Practical – IV Hydrogeology, Remote Sensing and GIS*	4	40	60	100	4
24	22UPAGIT	Internship Training	0	25	75	100	0
IV- Semester							
25	22UPAGC13	Mining and Engineering Geology	4	25	75	100	4
26	22UPAGE…	Elective VII/VIII	4	25	75	100	4
27	22UPAGPJ	Project/Dissertation	7	50	150	200	7
28	22UPAGVA	Value Added Courses	4	25	75	100	0
29	2UPAGAO	Add on Courses	4	25	75	100	0
Elective Courses							
1	22UPAGE01	Fuel Geology	4	25	75	100	4
2	22UPAGE02	Analytical and Instrumentation Techniques	4	25	75	100	4
3	22UPAGE03	Advanced Surveying Techniques	4	25	75	100	4
4	22UPAGE04	Meteorology and Climate Change	4	25	75	100	4
5	22UPAGE05	Geo-statistics	4	25	75	100	4
6	22UPAGE06	Geo-heritage and Geo-tourism	4	25	75	100	4
7	22UPAGE07	Environmental Geology and Disaster Management	4	25	75	100	4
8	22UPAGE08	Marine Geology	4	25	75	100	4
Supportive Courses							
1	22UPGS01	Earth and Environment	3	25	75	100	4
2	22UPGS02	Water Resources Management	3	25	75	100	4
3	22UPGS03	Gemmology	3	25	75	100	4
4	22UPGS04	Rainwater Harvesting and Artificial Groundwater Recharge	3	25	75	100	4
5	22UPGS05	Geohazards	3	25	75	100	4
Value Added (VA) Courses (Certificate Course – Extra credits)							

1	22UPAGVA01	Hydrology and Water Management	4	25	75	100	2
2	22UPAGVA02	Environmental Studies and Earth Sciences	4	25	75	100	2
Add on (AO) Courses							
1	22UPAGAO01	Medical Geology	4	25	75	100	2
2	22UPAGAO02	Petroleum Geology	4	25	75	100	2
3	22UPAGAO03	Groundwater exploration	4	25	75	100	2
SWAYAM Courses *(Study Webs of Active Learning for Young Aspiring Minds-SWAYAM)*							
1	22UPAGS01	Mineral Resources: Geology, Exploration, Economics and Environment	-				-
2	22UPAGS02	Introduction to Geographic Information Systems	-				-
3	22UPAGS03	Disaster Management	-				-
4	22UPAGS04	Introduction to Mineral Processing	-				-
5	22UPAGS05	Geology and Soil Mechanics	-				-
6	22UPAGS06	Geomorphic Process: Landforms and Landscapes	-				-
7	22UPAGS07	Global Navigation Satellite Systems and Applications	-				-
Note: I-Internal Mark, E-External Mark, M-Maximum mark, C- Credits							

XIX. Passing Minimum

A candidate has to secure a minimum of 50% mark in each course and earn a minimum of 90 credits for the award of a Master's degree.

XX. Distribution of Marks

Theory

University Examination (External) : 75 marks
Internal Assessment : 25 marks

Distribution of Internal Assessment mark

Test : 10 marks
Attendance : 5 marks
Assignment : 5 marks
Seminar : 5 marks

Total Marks : 25 marks

Passing Minimum: Internal Assessment : No Minimum for Internal assessment
Passing Minimum: External Assessment : 50% - 38 marks (Mandatory)
Total Passing Minimum : 50 marks

Practicals

Internal Assessment : No Minimum for Internal assessment
University Examination (External) : 60 marks
Total Passing Minimum : 50 marks

XXI. Calculation of Internal Assessment mark

Attendance	:	05 marks
Practical Record Notes	:	10 marks
Practical Test	:	10 marks
Geological Field work, Sample Display and Report	:	15 marks
Total Marks	:	40 marks

Passing Minimum : Internal Assessment : 50% - 20 marks
Passing Minimum: External Assessment : 50% - 30 marks
Total Passing Minimum : 50 marks

Everything should be supported by proper record separate passing minimum is necessary for Internal and External.

XXII. Project/Dissertation

The student should undertake an individual project work during fourth semester under the guidance and supervision of a faculty. A faculty member may supervise the work of more than one student in related fields of study in adjacent field areas, but should be separate on topics. He/ she should choose a topic within the purview of the course curriculum. The work can be done in collaboration with the scientific research institutes/establishment/academic institutions on cooperating co-guides from that organization.

The student should submit a thesis (certified as authentic and bonafide by both supervising teacher and Head of the Department) prior to attending via-voce. The work done should be presented before the examiners and part of viva-voce. Submission of thesis prior viva-voce and presentation during it are mandatory requirements, without which course will be incomplete. If the candidate failed to attend the viva-voce, they are permitted to appear at the subsequent viva-voce examination.

Project Evaluation

Internal Assessment	:	50
Report Evaluation	:	50
Viva –Voce Examination	:	100
Total Marks	:	200

XXIII. Question Paper Pattern

Time: 3 Hours Max. Marks – 75

PART- A Objective Type: 20x1=20

(Answer all questions)

(Four questions from each unit)

PART-B Analytical Type: 3 x 5=15

(Answer any three questions)

(One question from each unit)

PART- C Descriptive Type: 5x8=40

(Answer all questions)

(One question from each unit with either or type)

XXIV. Syllabus

CORE COURSES

Syllabus for M.Sc., Applied Geology

22UPAGC01 – APPLIED GEOMORPHOLOGY

Course objectives

- To make the participant appreciative of natural geomorphic processes and use the acquired knowledge and skills.
- To apply for solving environmental issues, resource evaluation, exploration and management.
- To upgrade and teach the latest geomorphic tools.
- To understand landscape evolution through time and space.
- To understand various geomorphic processes that operates on the landscape.

Course Outcomes

- Knowledge on the natural geomorphic processes on their spatial and temporal scales and apply them in real-life situations.
- Analytical ability on recognition and discrimination on processes and events of geomorphic evolution on lab-field scale.
- Knowledge and skill on identification and interpretation of volcanic, tectonic, glacial and aeolian landforms on lab – field scale.
- Knowledge and skill on identification and interpretation of fluvial, coastal and marine landforms on lab- field scale.
- Knowledge on Indian landscape development and skills on the use of geomorphic processes, features and events in ground water exploration, environmental management and resource evaluation.

Unit I

Definition of Geomorphology. History of evolution and major milestones in the development of geomorphological concepts. Principles / laws of geomorphology. Geomorphological cycle – Davis and Penck, King, Hack and Gilbert models. Comparison of various schools of thoughts on principles and laws of geomorphology. Recent developments and current understanding on the geomorphic concepts. Intrinsic and extrinsic driving forces and resisting forces. Dynamic equilibrium between driving and resisting forces and Thresholds. Modern concepts, quantitative geomorphology, process geomorphology.

Unit II

Spatial and temporal scales in geomorphology. Mineral stability series. Weathering

processes and the physical, chemical and biological factors involved. Soil profiles, Types of soils. Erosional and Depositional landforms. Factors governing landscape evolution - tectonics, climate, slope, lithology, vegetation, land cover/land use and human. Agents of geomorphic processes — Volcanism, Gravity, glaciers, wind, rivers, tides, waves and currents.

Unit III

Isostasy, Climate zones of the World. Tectonic/Structural landforms, Classification of mountains, Types of volcanoes. Volcanic landforms. Gravity landforms. Genesis, distribution and types of glaciers. Landforms in glaciated regions. Aeolian process as a geomorphic agent. Aeolian landforms. Characteristics of dry and wet deserts.

Unit IV

Factors and characteristics of overland and subsurface flows. Fluvial process. Types of drainage patterns. River forms and processes – stream flow, stage discharge relationship; hydrographs and flood frequency analysis. Fluvial landforms. Types of Deltas. Classification of coastlines, Depositional and erosional coasts. Coastal and marine landforms.

Unit V

Geomorphological evolution of Indian Peninsula. Himalayan landscape, Indo-Gangetic plains, Deccan Plateau, Coastal low lands. Application of Geomorphology in groundwater exploration, environmental and natural resource management. Geomorphic mapping methods and tools. Applications of geomorphology in mineral prospecting, civil engineering, hydrogeology and environmental studies.

Text/ Reference Books

1. Ahmad E. Coastal Geomorphology. Orient Longman, 1972.
2. Bloom. A.L. (1992), Surface of the Earth, Prentice Hall India, New Delhi
3. Cox A. Plate Tectonics and geomagnetic reversals. Freeman, 1973.
4. Gass, I.G., Smith, P.S & Wilson, R.C.L., 2nd Edn., (1972), Understanding the Earth, The English Language Books Society, London
5. Holmes. A, (1972), Principles of Physical Geology the English Language Book Society and Nelson
6. Jacob. J, Russel, R.D & Wilson, J.T (1959), Physicsand Geology, McGraw—Hill, New York.
7. Leopo1d,L.S, Wolman, K & Miller, J.P, (1970), Fluvial processes in Geomorphology, Eurasia Publishing House Pvt Ltd., New Delhi.
8. Richard Huggett (2007) Fundamentals of Geomorphology, II Edition
9. Robert, S.A. and Suzanne, P.A., (2010) Geomorphology—The mechanics and chemistry of landscapes. Cambridge University Press
10. Routledge N. Y. Ritter, D.F., Kochel, R.C.,Miller, J.R., (2002) Process Geomorphology, Waveland press.
11. Sagan, C. (1973). , Planetary Engineering on Mars, Icarus, 20,513.
12. Sharma. H.S. (1990) Indian Geomorphology, Concept Pub. Co., New Delhi.
13. Thornbury, W.D., (2004) Principles of Geomorphology. II edition, Wiley Eastern Ltd, New Delhi

14. Wyllie., P.J, (1971), Dynamic Earth, John Wiley & sons, New York. 13.
15. Ramkumar, M., (2009) Geological hazards: Causes, Consequences and methods of Containment. New India Publishers, New Delhi

Outcome Mapping

POs& PSOs/COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO 1	3	2	1	1	1	3	2	1	2	3	2	3
CO 2	3	2	1	1	1	3	2	1	2	3	2	3
CO 3	3	2	2	2	2	3	2	1	2	3	2	3
CO 4	3	2	3	3	3	3	2	1	2	3	2	3
CO 5	3	2	3	3	3	3	2	1	2	3	2	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding & K3- Applying.

22UPAGC02 - STRUCTURAL GEOLOGY AND GEOTECTONICS

Course objectives

- The dynamic instability of the lithosphere, continuous and discontinuous deformation takes place within the rocks in solid or semi-solid state
- To decipher the fundamentals of structures and the underlying physical processes of rock deformation and geotectonics.
- Describes the geological structures and identification of structural features.
- To recognize the structures in the field, their significance in the geological setup and exploration of geological resources.
- The student knows how to unravel the underlying deformation processes and mechanisms through an accurate geometric and kinematic analysis of these natural structures.

Course outcomes

- After completing this course the students able to identify the structures in rocks with respect to change in stress-strain, which includes analysis of faults, folds, and structural signatures, and tectonic setups.
- Accurate geometric description of the structures observed in natural deformed rocks, and petrofabric analysis.
- Measurement of various orientation data from the structures, plotting them in suitable diagrams and make a quantitative analysis.
- Basic concept of the rheological properties of rocks and their control on the deformation processes.
- Understanding deformation mechanisms at micro, meso and macroscopic scales.

UNIT I

Principles of geologic mapping and map reading, Projection diagrams, Stress and strain ellipsoid and stress-strain relationships of elastic, plastic and viscous materials; Strain markers in deformed rocks; Fundamental concepts of rock deformation, Mechanical properties of rocks, Forces and mechanism of rock deformation; primary and secondary structures; geometry and genesis of planar and linear structures (bedding, cleavage, schistosity, lineation), Types of homogenous strain. Stress- Strain diagrams and their use in studying the stages of deformation and factors affecting deformation. Progressive deformation and finite strain. Measurement of strain in two dimensions. Deformation, Stress and Strain, Time relationship between crystallization and deformation.

UNIT II

Brittle and shear failure, Faults and fractures. unconformities; L-, L-S-, and S-tectonic

fabrics concepts of Flinn Diagram and Mohr's diagram for stress representation, fault geometry and nomenclature. Features of fault planes and fragmental rocks produced by faulting. Lineaments and Deep fractures. Joints, Analysis of fractures. Ductile and Brittle-Ductile shear zones. Stress and strain ellipsoids and their application in the study of fractures. Stereographic projection; shear zones, thrusts and superposed folding; basement-cover relationship. Interpretation of geological maps.

UNIT III

Geometric and genetic classification of cylindrical folds. Canoe fold and inverted canoe fold. Minor folds and their use in determining the major fold structure. Pumpelly's rule. Mechanics of folding. Superposed folding, simple fold interference patterns. Fold classification of Donath and Parker, and Ramsay. Attitude of beds, Measurement of dip, apparent dip, strike using Clino and Brunton Compass. Different types of failure and sliding criteria, π and β diagrams, histogram and rose diagram.

UNIT IV

Introduction to Structural Analysis and Fundamentals of geometric analysis. Tectonites, classification, tectonic fabric. Boudins, Foliation, axial plane foliation and its origin, fracture cleavages, crenulation cleavage. Transposed foliation. Use of axial plane foliation and fracture cleavages and the determination of major structures. Lineation, types, classification and origin. Application of stereographic and equal area projections in the representation of structures. Geometric analysis of folds and lineations. Concept of petrofabrics.

UNIT V

Geotectonics: Plate tectonics, nature of convergent, divergent and conservative plate margins. Plate tectonics in relation to igneous, sedimentary and metamorphic processes and mineralization. Triple junction, aulocogens, island arcs. Nature and origin of earth's magnetic field: Geomagnetic time scale. Force Balance and Mantle Plume models of plate movements; Orogeny and Epeirogeny; Anatomy of orogenic Belts, Tectonic framework of Southern Granulite Terrain (SGT). Shear zones in SGT- Moyar, Bhavani, Attur, Palghat-Cauvery and Achenkoil, Himalayan Orogeny; concept of super continent, their assembly and breakup.

Text / Reference Books

1. Badgley.P.C. (1965), Structural and Tectonic Principles, Harper International, New York.
2. Belousov,V.V.(1968).Structural Geology, Mir Publishers.
3. Billing, M.P.(1972).Structural Geology, Prentice-Hall.
4. Chiplonkar C.W. & Power K.B., (1988), Geological Maps, Dastane Ramchandra& Co., Pune.
5. Condie, K.C.,(1976).Plate tectonics and Crustal evolution.
6. Davis,G.H., 1984.Structural Geology of Rocks and Regions. John Wiley & Sons.
7. De Sitter. L.U. (1956), Structural Geology, McGraw Hill, New York.
8. Haakon Fossen, 2010. Structural Geology, Cambridge University Press.

9. Hill. E.S. (1972), Elements of Structural Geology, John Wiley, New York
10. Hobbs, B.E., Means, W.D. and Williams, P.F. John Wiley, (1976) An outline of structural geology,
11. Marshak S. and Gautam Mitra. Basic methods of Structural Geology. Prentice Hall Inc. 1988.
12. Paor, D. (1996). Structural Geology and Personal Computer, Pergamon,
13. Park, R.G., (1983). Foundations of Structural Geology, Blackie and Sons Ltd.
14. Philips F. C. Stereographic projection in Structural Geology. Arnold 1960. Lisle R. J. and Leyshon P. R. Stereographic Projection Techniques for Geologists and Civil
15. Ragan, D M John Wiley, (1985) Structural geology - An Introduction to Geometrical Techniques,
16. Ramsay.J.G & Huber.M.I, (1983), The Techniques of Modern Structural Geology: Vol I – Strain Analysis.
17. Ramsay.J.G & Huber. M.I, (1987), The Techniques of Modern Structural Geology: Vol II – Folds & Fractures
18. Rowland, S.M. and Duebendorfer, E.M. (1994).Structural Analysis and Synthesis, Pergamon,
19. Twiss, Robert J. and Moores, Eldridge M., (2007). Structural geology, W.H.Freeman and Company, New York., p.742
20. Uemura, T., and Mizutani, S., (1979). Geological Structures, Ed.Volume.John Wiley & Sons.
21. Windley, B.F.,(1976).The Evolving Continents. Jhon Wiley and, New York.

Outcome Mapping

POs& PSOs/COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO 1	3	2	2	2	3	3	2	2	1	2	3	3
CO 2	3	1	2	2	2	3	2	2	1	2	2	2
CO 3	3	2	2	2	3	3	1	2	2	2	2	2
CO 4	3	1	2	2	3	3	1	2	1	2	2	2
CO 5	3	1	2	2	2	3	1	2	1	2	1	2

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding & K3- Applying.

22UPAGC03 – CRYSTALLOGRAPHY AND MINERALOGY

Course objectives

- To understand the crystallography, it's internal and external structures and the classification of crystals into systems and classes and to know about the technique of x-ray diffraction pattern and their interpretation in mineralogy.
- To Study the physical chemical and optical properties of rock forming minerals.
- The course will lay the foundation for the broader understanding of the geology by imparting the basic knowledge about the rock forming minerals.
- To learn about minerals their formation, complexity, association, identification and allied technical contents and will also inculcate the basic idea of mineral interaction.

Course outcomes

- To identify common rock forming minerals using diagnostic physical, chemical, and optical properties.
- Learnt about crystallography and to infer the environment of formation of minerals.
- To understand earth processes, earth interior and earth history understanding of basic techniques of mineral characterization
- This course also focuses on the analytical methods used in the chemical analysis of minerals.
- Understanding the concept in geochemical and petrological studies and the paragenesis of minerals

Unit I

Crystallography: Atomic structure of Bonding in minerals, crystal, space lattice, 14 Bravais lattice and unit cell. Definition of crystals, Forms, Faces, Edges, Solid angles. Goniometer, Derivation of 32 crystal classes of symmetry, Elements of Symmetry. Crystal Parameters: Weiss and Millerian system of crystal notation. Interfacial angles and their measurements. and Napier's theorem , Stereographic and Gnomonic projections of natural crystals of normal classes, Twin crystals and Irregularities of crystals. Concept of point group, space group.

Unit II

X-rays study of crystal: Bragg's law, X-ray diffraction method, Application of X-rays in the study of crystal structures. Classification and structure of silicates and clay minerals. Mineral identification by X-rays and Differential Thermal Analysis (DTA).

Unit III

Mineral optics: Nature of light, polarized light. Double refraction. Snell's law. Parts and function of petrological microscope. Optical properties of minerals, Optic sign, scheme of pleochroism and sign of elongation, uniaxial and biaxial minerals. Relative relief (RI) of minerals by Becke-line test. Extinction angle and its types.

Unit IV

Crystal chemistry: Crystalline and amorphous, Isomorphism, Polymorphism, Pseudomorphism, Polytipism, Polysomatism, Solid solution series and Exsolution. Physical properties of minerals. Chemical classification of minerals. Precious and semiprecious minerals. Chemical identification of industrial and ore minerals.

Unit V

Rock and ore forming minerals: Physical, chemical, optical properties and mode of occurrence of quartz group, feldspar group, pyroxene group, olivine group, amphibole group, mica group, and garnet group. Paragenesis and mode of alteration: Silicates, oxides, carbonates, sulphates, sulphides and halides. Application of SEM, TEM and EPMA in mineral characterization.

Text / Reference Books

1. Andrew Puttins.,(1992), Introduction to mineral sciences, Cambridge University Press.,
2. Battey,M.H.,(1972),Mineralogy for students,
3. Berry Mason, (2004), Mineralogy, CBS Publishers, New Delhi.
4. Brian Mason, (1966), Principles of Geochemistry, Wiley & Sons, New York.
5. Dana E. S. Textbook of Crystallography, Revised by Ford W E, Wiley, 1962.
6. De Jong,W.F.,(1955), General crystallography, Freeman.
7. Deer, W., Howie, R.A. & Zussman, J., (1996), The Rock forming minerals. Longman.
8. Hans-Rudolt Wenk and Andrei Bulakh.,(2004), Minerals – Their constitution and origin. Cambridge University Press.
9. Hurlbut.C.C, (1961), Dana's Manual of Mineralogy, New York
10. Hutchison, C.S., (1974), laboratory handbook of Petrographic Techniques. John Wiley.
11. Joseph .V.Smith., (1982), Geometrical and structural crystallography. John Wiley& sons.
12. Keith Frye.,(1974), Modern Mineralogy. Prentice-Hall.Inc New Jersey.
13. Klein, C and Hurbut, Jr., C.S. (1993), Manual of Mineralogy. John Wiley.
14. Kerr.P.F. (1959), Optical Mineralogy, McGraw Hill, Tokyo.
15. Martin.J.Burger.,(1970), Contemporary Cyrstallography. McGraw-Hill book company.
16. Oliver and Boyd. Dana,E.S.(1962),Text book of Mineralogy Revised by

Ford,W.E.Wiley.

17. Phillips, Wm, R. & Griften, D.T., (1986), Optical Mineralogy, CBS edition.
18. Phillips,F.C.,(1963),Introduction to crystallography, Thomas Nelson.
19. Phillips,W.J..&N.,(1980), An introduction to mineralogy for geologist. John Wiley& sons.
20. Putnis Andrew., (1992), Introduction to Mineral Science, Cambridge University Press.
21. Wahlstrom E. E. Optical Crystallography, Wiley, 1962.
22. Winchell A. N. Elements of optical mineralogy, Pt I, Wiley, 1951.

Outcome Mapping

POs& PSOs/COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO 1	2	3	1	2	2	2	2	3	2	2	1	1
CO 2	2	2	1	2	3	2	2	3	2	2	1	2
CO 3	2	2	2	2	3	2	2	3	1	2	2	2
CO 4	2	2	2	2	2	2	2	3	1	2	2	1
CO 5	2	1	2	2	2	2	2	3	2	2	1	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding & K3- Applying.

22UPAGC04 – PALAEONTOLOGY

Course objectives

- To make the participant to acquire knowledge on ancient life, skills on identification and documentation of paleobiota.
- To use the skills for characterizing ancient climate, environment and catastrophies and resource exploration.
- The knowledge in palaeontology is to equip the students for understanding the paleo environment.
- To educate various aspects biological events such as origin of life, evolution, mass extinctions, radiations, paleo-ecology, exceptional preservation, and functional morphology.
- To prepare the students for professional job perspective in the field of basic paleontological research, to benefit them in the preparation of various exam.

Course Outcomes

- To enhance knowledge on origin and evolution of life, classification systems of paleobiota, major catastrophic extinction events of life history.
- Analytical ability and knowledge on recognition, classification and interpretation of invertebrate fossil groups.
- Analytical ability and knowledge on recognition, classification and interpretation of vertebrate fossil groups, interpretation of lifestyles of paleobiota.
- Analytical ability to and knowledge on recognition, classification and interpretation of nanofossils, ichnofossils.
- Application of paleontology for paleoenvironment, climate, age determination, and hydrocarbon exploration.

Unit I

Principles

Definition of palaeontology and its recent development into palaeobiology. Theories on the origin and evolutionary history of Life; Megafossils and Microfossils; Modes of preservation of fossils. Nature of fossil record. Morphological description based taxonomic classification and Nomenclature. Definitions for Species, index fossil, trace fossil, cosmopolitan species, fossil assemblage, fossil diversity and phylogeny. Geological time scale. Biostratigraphy and types of biozones. Cladistics. Species evolution, proliferation and extinction through time.

Unit II

Invertebrate Paleontology I

Morphological characterization, systematic taxonomy, age, distribution and environmental preferences and associations of Anthozoa, Trilobita, Graptoloidea, Porifera and Bryozoa.

Unit III

Invertebrate Paleontology II

Morphological characterization, systematic taxonomy, age, distribution and environmental preferences and associations of Brachiopoda, Bivalvia, Gastropoda, Cephalopoda and Echinoidea.

Unit IV

Vertebrate Paleontology

Nature of evolutionary developmental events of Reptilian, Avian, Piscean and Amphibian fauna. Evolution of mammals. Evolution of Hominidae, Equidae and Probiscidae, its functional morphology.

Unit V

Paleontological applications

Introduction to palynology, paleobotany, micropaleontology, ichnology, taphonomy and basin analysis. Application of paleontology in palaeoenvironmental studies, age fixation and stratigraphic correlation, hydrocarbon exploration, plant fossils in Indian stratigraphy.

Text / Reference Books

1. Arnold.R (1947), An Introduction to Palaeobotany, McGraw Hill, New York
2. Arumugam (1989), Organic evolution, Sara Publication, Kanyakumari
3. Benton, M.J. and Harper, D.A.T., (2009) Introduction to Paleobiology and the fossil record. Wiley-Blackwell. London.
4. Clarkson E.N.K. (1986). Invertebrate paleontology and evolution. George Allen & Unwin.
5. Colbert, E. (1955), The Evolution of Vertebrates, John Wiley, New York.
6. Jain, P.C &Anantharaman, M.S (1996), Palaeontology, Evolution and Animal Distribution, Vishal Publications
7. Moore R.C., Lalicker & Fisher (1952). Invertebrate fossil. McGraw Hill Book Co., San Francisco.
8. Murray, J.W., (1985) Atlas of invertebrate macrofossils. Longman. London.
9. Nield, E.W. and Tucker, V.C.T., (1985) Palaeontology: An introduction. Pergamon Press Ltd., Oxford.
10. Raup D.M. & Stanley (1985). Principles of paleontology. CBS Publ. & Distributors, New Delhi.
11. Romer, A.S (1959), The Vertebrate Story, University of Chicago Press 4thEdt. Chicago
12. Sherlock, R.R &Twenohoefel, W.H (1953), Principles of Invertebrate

Palaeontology, New York
13. Swinnerton, H.H (1961), Outlines of Palaeontology, Edward Arnold Publ. Ltd., London.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	2	2	2	2	2	2	2	2	2	2	3	2
CO 2	2	2	2	3	2	2	1	2	2	2	2	2
CO 3	2	2	2	3	2	2	1	1	2	2	3	1
CO 4	2	2	1	3	2	2	2	1	2	2	2	1
CO 5	2	2	1	3	3	2	1	2	2	2	2	1

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding & K3- Applying.

PRACTICAL - I
22UPAGP01 - STRUCTURAL GEOLOGY, MINERALOGY AND PALAEONTOLOGY

Course objectives

- Practical training to the students on various geological skills. Identification of topographical and structural features. Mapping techniques and on understanding various geodynamic processes for exploration of oil and economic minerals and also to impart analytical and interpretational skills with better understanding to the students on various structural elements and geological maps etc.
- Practical training to the students on mineral identification, crystal systems and chemical composition
- Imparting skills to identify fossils, interpret age, biozones, paleoenvironment and climate, resource exploration, etc.

Course Outcomes

- The Students will be trained on professional aspects of geological mapping.
- They will have good training on identification of crystals and rock forming mineral and economic ores.
- It will provide Skill development on accurate identification of fossils for systematic palaeontology, age determination, stratigraphic correlation and functional morphology.
- To enhance on Interpretation of age and stratigraphic correlation protocols.
- To learn about the Interpretation of fossil morphology and statistical data on paleoclimate and paleoenvironment.
- Stratigraphic subdivision of strata based on faunal community, diversity and population distribution.

Structural Geology

1. Preparation and interpretation of geological maps and sections.
2. Structural problems concerning economic mineral deposits.
3. Stereonet plotting and interpretation of petro fabric data and resultant diagrams.

Mineralogy

4. Study of symmetry and forms in the crystal models.
5. X-rays and X-ray refraction, Powder method, Determination of unit cell parameters.
6. Crystal projections –Stereographic projection, Spherical Projection and Gnomonic projection.

7. Study of common rock forming minerals under petrological microscope.
8. Determination of relative relief (RI) of minerals by Becke-line test.
9. Determination of sign of elongation of minerals.
10. Determination of pleochroic scheme of minerals.
11. Determination of optic sign of uniaxial and biaxial minerals.
12. Determination of extinction angle and its types.
13. Identification of rock forming minerals in hand specimens.
14. Chemical examination of Industrial and ore minerals / Blowpipe analysis.

Palaeontology

Recognition of fossils, taxonomic classification, assignation of age and based on morphological characteristics of fossils belonging to Trilobita, Gastropoda, Bivalvia, Cephalopoda, Brachiopoda, and Echinodermata.

Interpretation of palaeoclimate and palaeoenvironment based on fossil data.

Biostratigraphic zonal assignment.

Identification of source, reservoir and seal facies with fossil data.

Text / Reference Books

1. Basic Methods of Structural Geology by Stephen Marshak and Gautam Mitra. 1988, Prentice Hall.
2. Structural Geology: Fundamental and Modern Developments by Ghosh, S.K., 1993, Pergamon Press.
3. Techniques of Modern Structural Geology. Vol. II. Folds and Fractures by Ramsay, J.G. and Huber, M.I., 1987, Academic Press.
4. Murray, J.W. (1985), Atlas of Invertebrate Macrofossils, Longman.
5. Woods, H. (1966), Invertebrate Palaeontology, International Book Bureau,

Outcome Mapping

POs& PSOs/ CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	2	2	3	3	1	3	2	3	3	2	3	2
CO 2	2	2	3	3	1	3	2	3	3	2	2	2
CO 3	2	2	3	3	1	3	2	3	3	2	3	3
CO 4	2	2	3	3	1	3	2	3	3	1	2	2
CO 5	2	2	3	3	1	3	2	3	3	1	2	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding, K3- Applying & K4-Analysing.

22UPAGC05 - IGNEOUS AND METAMORPHIC PETROLOGY

Course objectives

- To understand igneous processes, physical and chemical characteristics of magma and various rock types its geological setting, petrogenesis, classification, and natural characteristics, textures and structures,
- To enhance inputs on tectonomagmatic through geological mileu by the study of these rocks.
- To identify critical mineral assemblages, textural and mineral chemical data
- To gain knowledge on theoretical basis for interpreting this data for past geodynamic processes, especially the orogenic events.
- To infer the metamorphic agents and formation of metamorphic rocks.

Course Outcomes

- This course offers the students a detailed idea about the magma, its characteristics diversity and its generation with respect to different tectonic settings.
- The students gain knowledge on experimental models for the crystallization – melting processes in the deep crust and in the mantle.
- This intends to provide a detailed understanding of the important igneous rock types found on earth with special reference to petrogenesis.
- Metamorphic petrology offers a clear understanding in metamorphic processes and reactions.
- It impart the students a comprehensive knowledge in experimental petrology, geothermobarometry and relation between metamorphism and plate tectonics.

Unit – I

Igneous petrology and its scope, differentiation of the Earth, major structural units of the Earth, energy and mantle heat engine, gravity, pressure and geobaric gradient, viscosity of melts chemical diffusion, heat diffusion, nucleation and crystal growth, vesiculation and fragmentation of magma, Magma types and their evolution; igneous rock series. Chemical dynamics of melts and crystals Textures: The IUGS classification, forms, structures and textures of igneous rocks; applications of binary and ternary phase diagrams in petrogenesis; magmatic differentiation and assimilation.

Unit – II

Magma Diversity: Partial melting- Magmatic differentiation - Fractional crystallization, Volatile transport, Liquid immiscibility, Magma mixing and Assimilation. Basics of thermodynamics and Phase diagrams: Gibbs free energy – the Gibbs free energy for a

phase – Gibbs free energy for reaction - Phase equilibrium and the Phase rule - One component system (SiO2)- Two (binary) component system – Binary systems with complete solid solution (Plagioclase system, Ab-An) – Binary Eutectic System (Diopside – Anorthite) – Binary Peritectic systems.

Unit – III

Classification and Nomenclature of igneous rocks: calculations and plotting – Phaneritic rocks – Aphanitic rocks – Pyroclastic rocks. Magmatic Petrotectonic Associations: Oceanic spreading ridges and related basaltic rocks – Mantle plumes and oceanic island volcanic rocks – Plume heads and basalt flood plateau lavas – Arc magmatism – Oceanic island arcs – Continental margin magmatic arcs. Paragenesis: Ophiolite – Characteristics – origin and emplacement – Anorogenic A –type felsic rocks – characteristics – petrogenesis of granites, basalts, komatiiites and alkaline rocks (carbonatite, kimberlite, lamprophyre and nepheline syenite).

Unit – IV

Introduction - Significance of metamorphic studies, Definition and limits of metamorphism, Overview of different types of metamorphism; Factors controlling transformations. Types of metamorphism: Contact Metamorphism: Pyrometamorphism – Regional metamorphism: Orogenic Metamorphism – Burial Metamorphism – Ocean Floor Metamorphism – Hydrothermal Metamorphism – Fault-zone Metamorphism - Metamorphic structures and textures – The processes of deformation, recovery, and recrystallization- Textures of contact metamorphism – High-Strain metamorphic textures – Regional orogenic metamorphic textures –Gneissose structure and layers – Deformation versus metamorphic mineral growth – Analysis of polydeformed and polymetamorphised rocks – Replacement textures and reaction rims. Classification of metamorphic rocks: Foliated and lineated rocks – Non-foliated and non-lineated rocks- Specific metamorphic types – High-strain rocks.

Unit – V

Stable Mineral Assemblages in Metamorphic rocks: Equilibrium Mineral Assemblages – The Phase rule in Metamorphic systems – Chemographic diagrams: The ACF diagram –The AKF diagram – Projecting in chemographic diagrams. Metamorphic facies and facies series – Metamorphism of mafic rocks – Metamorphic fluids, Mass transport and Metasomatism - Anatexis and migmatites - Geothermobarometry.

Text / Reference Books

1. Alexander R. McBirney, 2nd Edti., (1993), Igneous Petrology, CBS Publishers and Distributors, New Delhi.

2. Asworth,J.R.(Ed) (1985), Migmatites. Blackie.

3. Baskar Rao,B.(1986), Metamorphic Petrology. Oxford &IBH.

4. Best,M.G.(2002), Igneous and Metamorphic Petrology,2nd edition, Blackwell Publishers.

5. Bose, M.K, (1997), Igneous Petrology, The World Press Pvt Ltd., Calcutta.

6. Bowen N.L.(1995), The evolution of Igneous Rocks –Princeton University Press, Carmichel,I.S.E.

7. Carmichael.I.S.E,Turner.F.J and Verhoogen.J, (1974), Igneous Petrology McGraw – Hill, New York.

8. Chatterjee, S.C (1974), Petrography of the Igneous and Metamorphic rocks of India Macmillan.

9. Cox,K.G., Bell.J.D and Pankhrust.,R.J.(1979),Interpretation of igneous rocks.George Allen Unwin

10. Ernst.W.G, (1976), Petrologic Phase Equilibria, W.H. Freeman & Co, USA.

11. Freeman W.H.(1982), Petrography, An introduction to the study of rocks in thin sections - Howell, William and Turner.

12. Hall,A.(1987), Igneous Petrology. Longman Scientific &Technical.

13. Harker A. (1909), Natural Histroy of Igneous rocks –Mc.Millan.

14. Hyndman,D.W,(1985), Petrology of igneous and metamorphic rocks. McGraw Hill.

15. Loren A. Raymond, WCB Publ. (1995), Petrology, The Study of Igneous, Sedimentary and Metamorphic Rocks.

16. Mason R, (1984), Petrology of Metamorphic Rocks, CBS Publishers & Distributors, New Delhi

17. Mason,R.(1984),Petrology of metamorphic rocks.CBS Publishers and Distributors.

18. McBirney,A.R.(1993), Igneous Petrology.CBS Publishers and Distributors.pp.508.

19. Miyashiro,A (1973), Metamorpism and Metamorphic belts, John Wiley and Sons, New York

20. Nockolds,S.R., Knox O.B., Chinner,G.A (1979), Petrology for Students, Cambridge University Press.

21. Philpotts A. R.(1990), Principles of Igneous and Metamorphic Petrology,Prentice

Hall.

22. Robin Gill. (2010), Igneous Rocks and Processes: A Practical Guide Wiley-Blackwell Publ.,

23. Spray, A.H.(1969), Metamorphic textures. Pergamon Press.

24. Turner,F.J.&Verhoogen,J.(1974),Igneous Petrology. McGraw Hill.pp.694

25. Turner,F.J.(1980),Metamorphic Petrology. McGraw Hill.

26. William,H, Turner,F.J, &Gilbert,C.M, (1954), Petrography, San Fransisco

27. Winkler.H.G.E.(1979), Petrogenesis of metamorphic rocks. Springer Verlag.

28. Winter, John D., (2012) Principles of Igneous and Metamorphic Petrology, Pearson Education Inc., Publishing as Pearson Prentice Hall, New Jersey, U.S.A.pp.702.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	2	2	2	3	2	2	2	2	3	3	1	2
CO 2	2	2	1	3	3	2	2	1	2	2	2	2
CO 3	2	2	2	3	3	2	2	2	2	2	1	3
CO 4	2	2	1	3	2	2	2	2	3	1	2	1
CO 5	2	2	2	3	3	2	2	1	2	1	1	2

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

22UPAGC06 – SEDIMENTOLOGY AND BASIN ANALYSIS

Course Objectives

- To make the student to understand sedimentary processes, interpret depositional conditions, paleoenvironment and climate through sedimentary archives.
- To identify potential zones of interest for natural resource exploration and environmental impact assessment.
- To explain different sedimentary rocks, their mode of formation and processes.
- To educate knowledge of different sedimentary basins and their economic importance are also significant for economic and mineral exploration.
- To prepare students for the application of sedimentology in other applied subjects.

Course Outcomes

- Gain Knowledge on principles of sedimentary processes, skills on recognition of sedimentary systems and data logging.
- To make them trained on recognition and interpretation of different types of sedimentary rocks, internal structures and processes.
- Analytical ability and skills to differentiate various types of factors controlling sedimentary systems, based on facies characteristics, successions and contact relationships.
- To offer the students a detailed idea about the use of fossil data on identification of source, seal and reservoir facies types to aid in hydrocarbon exploration.
- Enable Students to evaluate the record of tectonic & climatic processes through geological time

Unit I

Principles

Evolution of principles and concepts of Sedimentology. Understanding Sedimentology as an interdisciplinary subject of geoscience. The temporal (time) and spatial (areal extent) scales of sedimentary processes and products. Scope of preservation of sedimentary records and completeness of sedimentary events and processes in sediments and rocks. Types of sedimentary data collection modes and their scopes and limitations.

Unit II

Types of rocks and their differentiation in rock cycle. Sedimentary processes involved in sediment production, transport, deposition and final preservation/burial. Bedforms and types, physical, chemical and biological sedimentary structures. Sediment texture – classification of unconsolidated sediments, siliciclastics, carbonates, evaporates, volcanoclastics, and miscellaneous types.

Unit III

Understanding the four major controlling factors of sedimentation – Tectonics, eustatic cycles, climate and sediment influx on sedimentary basin formation and fill. Facies concepts. facies association, facies succession, depositional models. Facies successions formed under gravity, glacial, lacustrine, aeolian, fluvial, and marine (coastal and deep sea environments) processes.

Unit IV

Criteria for classification of sedimentary basins. Sedimentary basin formation and basin filling. Diagenesis of sediments – Stages, zones and environments of diagenesis. Compaction, Porosity types and evolution, cementation, neomorphism, dissolution-recrystallization, dolomitization, and silicification. Palaeocurrent, heavy mineral, clay mineral and geochemical analyses for paleoclimate, paleoenvironment, tectonic setting and provenance analysis.

Unit V

Nature and classification of Sedimentary basins of India. Applications of Sedimentology for palaeoclimatic and palaeoenvironmental interpretation. Study of sedimentary geochemistry for understanding depositional and diagenetic processes. Applications of sedimentology for petroleum exploration and reservoir characterization.

Text /Reference Books

1. Collins J.D. and D.B. Thompson (1982) Sedimentary Structures. George Allen & Unwin, London.

2. Flugel, E.V., (2002) Microfacies analysis of limestones. Elsevier.

3. Leeder, M., 1999. Sedimentology and Sedimentary Basins. From Turbulence to Tectonics. Blackwell, Oxford, 592 pp

4. Lindholm, R., (1988) A practical approach to Sedimentology. Blackwell publication.

5. Nicholls, G. (1999) Sedimentology and Stratigraphy. Wiley-Blackwell,.

6. Pettijohn F.J. (1975) Sedimentary rocks. Harper and Row Publ., New Delhi.

7. Selley, R.C., (2000) Applied sedimentology, 2nd Edn., Academic Press,.

8. Sengupta.S.M, (2007), Introduction to Sedimentology, CBS Publishers & Distributors, New Delhi.

9. Tucker M.E. and V.P.Wright (1990) Carbonate Sedimentology. Blackwell publication.

10. Ramkumar, M., (Editor) 2015 Chemostratigraphy: Concepts, techniques and aplications.Elsevier.530p. sciencedirect.com/ science/ book/ 978012419968.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	3	2	1	3	2	2	1	1	1	3
CO 2	3	2	2	1	1	3	3	1	1	2	2	2
CO 3	3	2	3	2	1	3	2	2	1	1	2	2
CO 4	3	2	2	2	2	3	3	1	1	1	2	3
CO 5	3	2	2	2	3	3	2	1	1	2	1	2

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

22UPAGC07 - STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY

Course Objectives

- To make the students to understand the basic principles of stratigraphy.
- To understand the stratigraphic classification, Geologic time scale, nomenclatures.
- Major stratigraphic units, stratigraphic correlation, depositional environments, tectono stratigraphic framework of various stratigraphic units of India.
- Major stratigraphic and extinction boundaries.

Course Outcomes

- Acquire knowledge on the Tectonic Framework of India, Cratons, Mobile Belts and important Precambrian and Proterozoic successions of Peninsular India, Cambrian explosion and response of biosphere including Precambrian-Cambrian boundary events.
- Realize the importance of Paleozoic history, plate tectonic movements, life, stratigraphic successions Paleozoic, Permo-Triassic boundary in India, Gondwana Sequence of India, Paleo-climate and sedimentation.
- Learn the subdivisions of Mesozoic Era, Tectonic history, stratigraphic successions, Paleo-life, igneous provinces and their role in mass extinction, important mass extinction boundary sections.
- Obtain the knowledge on Cenozoic history, stratigraphic classification of Siwalik Group, Assam-Arakan region, Andaman-Nicobar Islands, boundary problems.

Unit I

Principles of Stratigraphy: Stratigraphic Principles and approaches to measurement of geological time. Recent developments in stratigraphic classification and Geological Time Scale. International Stratigraphic Code- development of a standardized stratigraphic nomenclature. Concepts of Strato types, Global Strato type Section and Point (GSSP). Principles of Stratigraphic Classification, Categories of Stratigraphic Classification and concept of Litho, Bio and Chrono Stratigraphy. Brief idea about sequence, magneto-seismic- chemo- and event, cyclo- Stratigraphy. Stratigraphic correlations. Approaches to paleogeography.

Unit II

Precambrian stratigraphy: Precambrian stratigraphic succession of and economic importance of Dharwar Supergroup, Eastern Ghats and Southern Granulite belt, Singhbhum -Chhota nagpur-Orissa belt with special reference to Sausar, Sakoli and Iron Ore Groups, Dongargarh and Aravalli Supergroups. Proterozoic stratigraphy of Cuddapah, Vindhyan, Delhi Supergroups and their equivalents. Precambrian-Cambrian boundary.

Unit III

Paleozoic stratigraphy: History, tectonics, life and paleogeography during the Paleozoic Era. Stratigraphic frame work and fossil contents of the Paleozoic rocks of India with special reference to Kashmir and Spiti. Permian-Triassic boundary.

Gondwana stratigraphy: Concept, classification, sedimentation and paleoclimates, fauna, flora, age and economic potential of Gondwana Supergroup.

Unit IV

Mesozoic stratigraphy: Classification, geographic distribution, lithologic characteristics, fauna and flora economic potential of Triassic, Jurassic and Cretaceous systems in principal basins of India with special reference to Triassic of Spiti, Jurassic of Kutch and Cretaceous of Tiruchirappalli (formerly Trichinopoly). Deccan traps. Cretaceous-Tertiary boundary.

Unit V

Cenozoic stratigraphy: Classification, depositional characteristics, fauna and flora and economic potential of the Palaeogene, Neogene and Quaternary Systems with special reference to Siwalik Group, Assam-Arakan region, Andaman-Nicobar Islands and its equivalents. Himalayan orogeny. Quaternary deposits and their significance. Paleogene-Neogene and Neogene-Quaternary boundary.

Text / Reference Books

1. Danbar, C.O. and Rodgers, J. (1957) Principles of Stratigraphy. John Wiley & Sons.

2. Doyle, P. & Bennett. M.R. (1996) Unlocking the Stratigraphic Record (John Willey).

3. GSI Misc. Publn. No. 30. (2006) Geology and Mineral Resources of the States of India

4. Krishnan, M.S. (1982) Geology of India and Burma. CBS Publishers, Delhi Naqvi, S.M. and Rogers, J.J.W. (1987) Precambrian Geology of India. Oxford University Press.

5. Pascoe, E.H.(1968) A Manual of the Geology of India & Burma (Vols.I-IV) Govt. of India Press, Delhi

6. Ramkrishnan, M. and Vaidhyanadhan, R. (2008) Geology of India,Volume I and II, Geological Society of India, Bangalore

7. Ravindra kumar. (1985) Fundamentals of Historical Geology and Stratigraphy of India. Wiley Eastern Ltd., New Delhi.

8. Robert, M. S. (1989) Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York. ,

9. Wadia, D.N. (1998) Geology of India. Tata McGraw Hill, India.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	2	2	3	2	3	2	2	3	2	3	2	1
CO 2	2	2	2	2	3	2	3	3	3	3	2	1
CO 3	2	1	2	2	3	2	1	3	2	3	2	2
CO 4	2	1	2	3	3	2	2	2	2	3	2	1
CO 5	2	1	1	3	3	2	2	2	2	3	2	2

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

22UPAGC08 - GEOEXPLORATION

Course objectives

- This course presents a practical step-by-step description of the key geological field mapping techniques
- To educate on various types of mapping techniques fundamental to the collection, storage and presentation of geological data and useful for the location of ore deposits
- To enhance knowledge on Essentials of sampling and drilling techniques in surface and subsurface
- To know about the different types of surveys and provide an overview of quality assurance –
- To understand the quality control procedures for mineral exploration projects

Course outcomes

- The course reveals on various geophysical, geological, methods,
- It imparts the knowledge on exploration, grading of ores, drilling, and ore reserve estimation.
- It demonstrates on geochemical exploration and various methods of geochemical exploration, atmospheric and geobotanical survey techniques
- The course also deals with the various geophysical prospecting methods that can be used to find out the occurrence and extent of ore deposit, including the method of applications and limitations.
- To understand the Geochemical element distributions.

Unit I

Geological Exploration

Introduction: Ore genesis in relation to minerals exploration. Regional local parameters for exploration. *Exploration:* Geological techniques and procedures of exploration. Regional (concept-based) exploration-different stages, planning and operations. Resources and reserves-Classification of resources and reserves. Documentation of exploration data.

Unit II

Geological Mapping &Exploration Techniques

Geological mapping: reconnaissance and detailed mapping-Selection of sites for geological prospecting. Different stages of exploration: objectives and tasks involved; preliminary studies and reconnaissance surveys. *Geologic aspects of drilling*-Types of drills- drill bits, core / sludge recovery, core logging; Drilling methods, planning, selection of sites, angle and direction of bore-holes. *Methods of sampling*: Weighting of samples and calculation of

average grades-mathematical and statistical methods.

Unit III

Geophysical Exploration: I

Gravity method: Nature of gravity and its variation. Accuracy and precision of measurements. Gravimeters. Field procedures. Corrections. Free-air & Bouger anomalies. Interpretation of anomalies. Explorations for minerals. *Magnetic method:* Geomagnetic field and its variations. Magnetometers. Field procedures for land and airborne surveys. Exploration for minerals and oil and engineering sites.

Unit IV

Geophysical Exploration: II

Seismic method: Seismic waves and their speeds in rocks. Snell"s law. Critical refraction. Instruments and field procedures for seismic refraction method. Corrections, Interpretation of data. Seismic reflection methods for oil exploration. Equipment for seismic reflection. Time and depth sections. *Electrical methods:* Introduction to S.P method and its use. Resistivity, true and apparent D.C. resistivity, true and apparent D.C. resistivity equipment, electrode arrangement, field procedure, and use for mineral exploration and at engineering sites.

Unit V

Geochemical Exploration

Fundamentals of geochemical prospecting; Geochemical environments, mobility and distribution in dispersion of elements in primary and secondary environments; Geochemical exploration practices in different environments glacial, desertic and tropical; Methods of geochemical exploration: Lithogeochemical, pedogeochemical, biogeochemical, hydrogeochemical, atomogeochemical, geobotanical methods; Statistical analysis and interpretation of geochemical prospecting data.

Text / Reference Book

1. F.J. Pettijohn (1975) Sedimentary rocks. Harper and Row Publ., New Delhi.

2. Flugel, E.V., (2002) Microfacies analysis of limestones. Elsevier.

3. J.D. Collins and D.B. Thompson (1982) Sedimentary Structures. George Allen & Unwin, London.

4. Lindholm, R., (1988) A practical approach to Sedimentology. Blackwell publication.

5. M.E. Tucker and V.P.Wright (1990) Carbonate Sedimentology. Blackwell publication. Nicholls, G. Sedimentology and Stratigraphy.

6. Wiley-Blackwell, (1999) Selley, R.C., Applied sedimentology, 2nd Edn., Academic Press, 2000. Leeder, M., (1999) Sedimentology and Sedimentary Basins. From Turbulence to Tectonics. Blackwell, Oxford, 592 pp.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	2	3	3	1	2	2	2	1	1
CO 2	3	1	2	2	3	3	1	2	2	1	1	1
CO 3	3	1	2	2	3	3	2	2	3	2	1	2
CO 4	3	1	2	3	3	3	2	2	3	2	1	1
CO 5	3	1	2	1	2	3	2	2	3	1	1	2

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding, K3- Applying.

PRACTICAL - II
22UPAGP02 - IGNEOUS, METAMORPHIC AND SEDIMENTARY PETROLOGY

Course objectives

- To train practical works and hand out experiences in laboratory for identification of certain Igneous and metamorphic rocks in hand specimen and in petrological thin section.
- To educate the students for solving the practical problems in data analysis and interpretation.
- To develop knowledge on Statistical techniques in analyzing grain size data.
- Imparting skills to identify sedimentary rocks, processes and interpret paleoenvironment, climate, depositional and erosional events,
- To create zones of interest for environmental assessment, resource exploration**.**

Course outcomes

- Students will be able to address different rock types, their occurrence and distribution to look for economic exploration programme
- Skill development to identify sedimentary rock types and interpret their environmental setting granulometric data, interpret and characterize mode of transport, erosion/deposition characteristics and environments of deposition petrographically characterize sedimentary rocks through megascopic and thin section studies, to interpret depositional and diagenetic environments. Skill development to conduct heavy mineral analysis of sediments/sedimentary rocks to interpret provenance and basin history.
- Skill development to construct lithofacies logs based on field exposures/ and to interpret depositional models based on facies successions.

Igneous Petrology

1. Megascopy of ultramafic, basic, intermediate and acidic igneous rocks.
2. Microscopy of ultramafic, basic, intermediate and acidic igneous rocks.
3. Modal classification of ultramafic, and basic igneous rocks following the IUGS nomenclature.
4. Modal classification of intermediate and acidic igneous rocks following the IUGS nomenclature.
5. Chemical classification of igneous rocks in the (Na2O+K2O) vs SiO_2 diagram.

6. Calculation of the CIPW norm of gabbro
7. Calculation of the CIPW norm of diorite.
8. Calculation of the CIPW norm of granite
9. Calculation of the CIPW norm of syenite
10. Calculation of the CIPW norm of nepheline syenite.

Metamorphic Petrology

1. Megascopy of metamorphic rocks: slates, phyllites, schists and gneisses.
2. Megascopy of metamorphic rocks: amphibolites, charnockites, khondalites, eclogites.
3. Megascopy of metamorphic rocks: marbles and quartzites.
4. Microscopy of metamorphic rocks: slates, phyllites, schists and gneisses.
5. Microscopy of metamorphic rocks: amphibolites, charnockites, khondalites and eclogites.
6. Microscopy of metamorphic rocks: marbles and quartzites.
7. Construction and interpretation of ACF diagrams.
8. Construction and interpretation of AFM diagrams.

Sedimentology

1. Characterization and recognition of sedimentary rock types at megascopic scale.
2. Interpretation of sediment transport modes and depositional environmental conditions using sediment textural properties.
3. Characterization and interpretation of depositional and diagenetic conditions of sedimentary rocks through microscopic methods.
4. Separation and analysis of heavy minerals from unconsolidated sediments and understanding provenance.
5. Construction of facies succession and depositional models with facies characteristics

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	1	3	1	3	2	2	1	2	1	3
CO 2	3	2	1	3	2	3	2	2	1	1	1	1
CO 3	3	2	1	3	1	3	3	2	1	2	1	1
CO 4	3	2	1	3	2	3	2	2	1	1	2	2
CO 5	3	2	1	3	2	3	2	2	1	1	2	2

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying..

22UPAGC09 - ECONOMIC GEOLOGY AND MINERAL ECONOMICS

Course Objectives

- To study mineral deposits and processes of formation of deposits and the nature of different mineral deposits, its genesis and distribution of major ore minerals.
- To familiarize with the common ore minerals and their identifying criteria at various scales of study.
- To understand the genetic controls exerted by physical and chemical processes on ore formation in various geological settings.
- To provide the knowledge on geological processes responsible for mineral and ore formation, weathering and other secondary mineralization processes.
- To familiarize mode of occurrence of economic minerals, metallic and non-metallic minerals.

Course Outcomes

- This is the course which links directly to the industry and share the knowledge about a wide range of ore deposit the geometry of ore bodies, alteration patterns and assemblage of ore and gangue minerals
- It offers a detailed study of origin of economic mineral deposits, its identification, properties, and distribution in India.
- The students will be familiar with how, where, and when earth's most important ore deposits have formed,
- This course also aims at providing a comprehensive knowledge in reflective light optic and ore textures.
- The students get a basic concept of mineral deposit modeling.

Unit I

Scope of economic geology. Mode of occurrence and morphology of ore bodies and relationship with host rocks -Textures and Structures of ore and gangue minerals. Modern concepts of ore genesis. Fluid inclusions -Wall rock alteration. Geothermometry-geobarometry.

Unit II

Paragenesis and zoning in mineral deposits-Metallogenetic Epochs and Provinces. Structural, physico-chemical and stratigraphic controls of ore localization. Study of ore forming processes- Orthomagmatic processes- Sedimentary processes- Metamorphic processes- Hydrothermal processes. Ore deposits in relation to plate tectonics.

Unit III

Mineralogy, mode of occurrences, uses and distribution in India of the following metalliferous deposits – Iron, Manganese, Aluminium, Copper, Gold, lead, Zinc – Chromium, Molybdenum, Rare Earth Group of metals. Distribution of mineral deposits in Indian shield; geological characteristics of important industrial mineral and ore deposits in India- chromite, diamond, muscovite, Sn-W, Au, Fe-Mn, bauxite; minerals used in refractory, fertilizer, ceramic, cement, glass, paint industries; minerals used as abrasive, filler; building stones.

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, Calcite, Quartz, Feldspar, Clays, Kyanite, Sillimanite, Graphite, Talc, Fluorite, Beryl and Gem minerals.

Unit V

Strategic, critical and essential minerals; India's status in mineral production; co-products and byproducts; consumption, substitution and conservation of minerals; National Mineral Policy; Mineral Concession Rules; marine mineral resources and its laws.

Text/Reference Books

1. Anthony Evans, (1993) Ore Geology and Industrial Mineral, John Wiley & sons, USA,
2. Bateman Allan .M. (1962) Economic Mineral Deposits, Asian Publishing House, 2nd Edition.
3. Coggin, B. and Dey, A.K. (1955) India's Mineral Wealth, OUP.,
4. Craig, J.M. & Vaughan, D.J., (1981): ore Petrography and Mineralogy. John Wiley
5. Cuilbert, J.M. and Park,Jr. C.F.(1986): The Geology of Ore Deposits, Freidman.
6. Deb.S. (1980) Industrial Minerals and Rocks of India, Allied,.
7. Edwards, R. and Atkinson, K. (1986) Ore deposit geology, Ist Edition, Chapman and Hall. New Delhi,.
8. Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
9. Gokhale, K.V.G.K. and Rao , T.C (1978)- Ore deposits of India, their distribution and processing, Thompson press,.
10. James R. Craig and David J.Vaughan (1994): Ore Microscopy and Petrography.
11. Jansen M.L. & Bateman A.M.: (1981), Economic Mineral Deposits, John Wiley & Sons, Singapore.

12. Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits, Springer-Verlag.

13. Krishnaswamy.S . - India's Mineral Resources, oxford and IBH.

14. Lindgren W. (1933) Mineral Deposits, Mc Graw Hill,.

15. Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.

16. Park, C.F. and Mac Diarmid, R.A (1970) Ore deposits, Freeman,

17. R.M. Umathay, (2006)Mineral Deposits of India, Dattsons, New Delhi, India,

18. Ramdhor, P. (1969): The Ore Minerals and their Intergowths, Pergamon Press.

19. Robb, L. (2005)Introduction to ore-forming processes, Blackwell publishing, U.K.,.

20. Stanton, R.L. (1972): Ore Petrology, McGraw Hill.

21. Wolf, K.H. (1976-1981): Hand Book of Stratabound and Stratiform Ore Deposits, Elsevier Publ

22. Meher,D.N. Wadia, (1994), Mineral of India, National Book Trust, New Delhi.

23. Sinha.R.K and Sharma.N.L.(1970), Mineral Economics, Oxford IBH Publishing Co., New Delhi.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	1	2	3	3	2	2	2	2	1	1
CO 2	3	1	1	2	3	3	2	2	2	1	1	1
CO 3	3	1	2	2	3	3	2	2	3	1	1	1
CO 4	3	1	1	1	2	3	1	3	3	1	1	1
CO 5	3	1	1	3	2	3	1	3	3	2	1	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying.

22UPAGC10 - APPLIED MICROPALEONTOLOGY

Course Objectives

- Micropaleontology deals with the study of microscopic fossils or microfossils have a wide distribution in time and space, and their rapid and irreversible evolution and morphologically distinctive evolutionary stages make them excellent tools for measuring relative geologic time.

- To make the students to understand the applications of Micropaleontology in Geological Sciences include determination of the age of the sediments, biostratigraphy and correlation of strata, integrated stratigraphy, hydrocarbon prospecting and exploration, paleoclimate and paleoceanography, paleobiogeography, sea floor tectonism, tsunami, geo-archaeology, forensic studies, fisheries, architecture etc.

Course Outcomes

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

- Understanding the historical developments and recent trends in micropaleontological studies besides the field and laboratory techniques in the study of microfossils.

- Acquire knowledge on the types of microfossils, morphology, classification, geological history and applications of Foraminifera.

- Appreciate the value of Ostracoda in ecology and paleo-ecological studies. Gain knowledge on the importance of Calcareous Nannofossils in biostratigraphy besides to improve the acquaintance on Pteropods, Calpionellids, Calcareous Algae and Bryozoa.

- Obtain the knowledge on the Phosphatic, Siliceous and Organic-Walled Microfossils and their applications/ significance.

- Be skilled on the Application of Microfossils in biostratigraphy, hydrocarbon exploration, understanding causes and types bioevents, paleoclimate and paleoceanography etc.

Unit I

Principles of Micropaleontology: Microfossils - definition, types of microfossils, uses of microfossils in various fields of Geological Sciences and Industry. Definition, scope and relationship of micropaleontology with ocean sciences. Historical developments and recent trends in micropaleontological studies including deep sea drilling (JOIDES, DSDP, ODP, IODP, JGOFS). Modern field and laboratory techniques in the study of microfossils: surface and sub-surface sampling methods, processing and separation of microfossils, preparation of faunal slides and thin sections. Field and Laboratory equipments used for micropaleontological studies.

Unit II

Calcareous Microfossils I: Dimorphism, test morphology, wall structure, chamber shape and arrangements, aperture openings and ornamentation of foraminifera. Classification and evolution of foraminifera. Ecology, paleoecology and geological distribution of foraminifera. Application of foraminifera in stratigraphy with special reference to Jurassic, Cretaceous and Tertiary periods in India.

Unit III

Calcareous Microfossils II: Morphology, hinge types, ornamentation, sculpture, orientation of carapace, classification and geological distribution of Ostracoda. Significance of ostracodes in ecology and paleo-ecological studies. Sample preparation techniques, morphology, ecology, application and geological distribution of calcareous nannofossils. Brief study of pteropods, calpionellids, calcareous algae and bryozoa.

Unit IV

Phosphatic, Siliceous and Organic-Walled Microfossils: Extraction methods, outline of morphology, composition and stratigraphic significance of conodonts. Preparation techniques, major morphological groups and application of radiolarians. Sample collection, preparation techniques, morphology and application of diatoms. Maceration techniques, outline of morphology and application of fossil spores and pollen.

Unit V

Application of Microfossils: Application of microfossils in biostratigraphy - First Appearance Datum (FAD) and Last Appearance Datum (LAD), units of biostratigraphy and biostratigraphic correlation. Application of Microfossils in understanding patterns causes and types of global events. Micropaleontology in hydrocarbon exploration – sequence stratigraphy, subsidence analysis, thermal history and biosteering. Application of microfossils in interpretation of paleoenvironment and paleoclimate – paleobathymetry, back-tracking technique, paleo-temperature estimation and sea-level change, ocean eutrophication, acidification, environmental monitoring, paleoclimate and paleomonsoon. Application micropaleontology in oceanography, paleogeography and engineering geology.

Text / Reference Books

1. Armstrong, H. and Brasier, M.D., (2005). Microfossils. Blackwell Publishing.
2. Bignot, G., (1985). Elements of Micropaleontology. Graham and Trotman.
3. Brasier, M.D., (1980). Principles of Microfossils. George Allen & Unwin.
4. Glaessner, M.F., (1945). Principles of Micropaleontology.
5. Hafner Publishing Company. , Haq, B.U. and Boersma, A., (1998). Introduction to Marine Micropaleontology. Elsevier.
6. Jones, D.J.,(1969). Introduction to Microfossils. Hafner Publishing Company, New

York.

7. Jones, R.W., (1996). Micropaleontology in Petroleum Exploration. Oxford.

8. Kathal, P.K., (1997). Microfossils and their applications. CBS Publishers and Distributors.

9. Martin, R.E. (2000). Environmental Micropaleontology. Springer.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	2	3	3	2	2	2	3	2	1
CO 2	3	2	2	1	2	3	2	1	2	3	1	1
CO 3	3	1	2	3	2	3	1	1	2	3	1	1
CO 4	3	1	2	1	2	3	1	2	2	2	1	1
CO 5	3	2	2	1	3	3	2	1	2	3	2	1

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying.

22UPAGC11– HYDROGEOLOGY

Course Objectives

- To learn the fundamental components of hydrological cycle and distribution of fresh and salt water of the Earth.
- To impart theoretical, practical and field knowledge pertaining to Hydrogeological domain.
- To understand the physical, chemical and biological characteristics of water with special emphasis on pollution and contamination.
- To understand the relationship in between water and rock interaction and salt water intrusion and its remedial measures in the coastal aquifers.
- An ability to ethical, social, health and sustainable consumption of water resources.

Course Outcomes

- Capable of understanding the impact of water conservation methods in regional and national context.
- An ability to understand the importance of groundwater augmentation strategies.
- To perform socio economic analysis to evaluate the intangible benefits of artificial structures.
- Formulate and solve deterministic and optimization models for water resources.
- To get familiarization of principles and applications of various groundwater exploration techniques.

Unit I

Hydrogeology: Hydrologic cycle and its components, Origin and age of groundwater, Occurrence of groundwater, Global distribution of fresh water. Vertical distribution of groundwater. *Aquifers*: Types of aquifers. *Springs:* Types of springs. *Hydrologic properties of rocks:* Porosity, Permeability, Specific yield, Specific retention, Hydraulic conductivity, Transmissivity and Storage coefficient.

Unit II

Groundwater movements: Sub surface movement, Base flow, Effluent flow and

influent flow. Darcy's law, Reynold's number, Laminar flow and turbulence flow. *Water level fluctuation:* Water table and Piezometric surface and its fluctuations. *Pumping test:* objective, layout of the test and its measurements.

Unit III

Water well technology: Well types, drilling methods, construction of well, design of well, development and maintenance of wells. *Artificial recharge of groundwater:* Concept and methods. *Saline water intrusion in aquifers:* Saline water intrusion, Ghyben–Herzberg relation between fresh and saline water, Prevention and control of salt water intrusion in the coastal aquifers.

Unit IV

Groundwater quality: Chemical composition of groundwater, major cations and anions, trace elements and their sources. *Water quality measurements:* physical, chemical and biological parameters. *Graphical representation of hydrochemical data:* Piper's facies analysis. *Groundwater Contaminations and Pollutions:*

Problems related to arsenic and fluoride contamination, radio isotopes in hydrogeological studies. Trace element and health hazards, Impact of urbanization. Hydrogeochemical provinces of India.

Unit V

Groundwater exploration techniques: Surface investigation of groundwater-Geologic method, electrical resistivity method, seismic method, gravity and magnetic method. *Subsurface investigation of groundwater:* test drilling, water level measurements. Application of Geophysical logging in Groundwater exploration. Groundwater provinces of India.

Text / Reference Books

1. Alley, W.M., (1993), Regional Groundwater Quality-VNR, New York
2. Davies, S.N. and De Wiest, D.R., (1966), Hydrogeology-John Wiley& sons, Inc, New York,463p.
3. Fetter, C.W., (1990), Applied Hydrogeology-Mc Graw Hill, Publisher, New Delhi.
4. Freeze, R.A. and John,A., (1979), Groundwater, Cherry, Prentice Hall,Inc,604p.
5. Handa.O.P (1984), Groundwater Drilling, Oxford & I.B.H. Publishing Co.
6. Hiscock,K.,(2005), Hydrogeology, Principles and Practice, Blackwell Publishing,389p.
7. Karanth, K.R., (1987), Groundwater Assessment, Development and Management-Tata McGraw Hill New Delhi 720p.

8. Kazmann, (1973), Modern Hydrology, Harper and sons Publishers, New Delhi.

9. Manning,J.C.,(2007),Applied Principles of Hydrology, CBS Publishers and Distributers ,New Delhi.

10. Raghunath, H.M., (2007), Groundwater 3rd edition, New Age International Publishers,520p.

11. Reddy and Rami,J.P.,(2008), A Textbook of Hydrology, University Science Press, Bangalore.

12. Schwartz,F.W and Zhang,H.,(2003), Fundamentals of Groundwater, John Wiley& sons, Inc, New York,583p.

13. Shaw,E.M., (1994), Hydrology in Practice,3rd edition, Chapman and Hall,London,569p.

14. Subramaniam, V., (2000), Water-Kingston Publ. London.

15. Todd, D.K., (1980), Groundwater Hydrology-John Wiley & Sons Publishers, New York, 535p.

16. Tolman.C. (1972), Groundwater, McGraw Hill Book Company.

17. Walton.W.C. (1970). Groundwater Resource Evaluation, McGraw Hill Book Company.

18. Venkateswaran.S (2010) Groundwater exploration techniques, TNBH publishers, Chennai, Tamilnadu. ISBN 978-81-9234-992-3.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	3	3	1	2	3	2	2	1
CO 2	3	3	2	2	3	3	3	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	1	1	1
CO 4	3	3	2	2	3	3	2	2	2	1	2	2
CO 5	3	2	2	1	3	3	2	2	3	2	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying.

22UPAGC12 –REMOTE SENSING AND GIS

Course Objectives

- To learn basic of aerial remote sensing and its applications.
- To understand the physics of electromagnetic spectrum and learn satellite remote sensing.
- To get exposure of the theory and applications of digital image processing.
- To have training in GIS components, models and applications.

Course Outcomes

- Develop knowledge in basic of remote sensing, interpretation keys and applications.
- Formulate the relationship between EMR and Satellite remote sensing.
- Implement Digital image processing technique in geological applications.
- Operate GIS data model.
- Demonstrate GIS and GPS techniques for varies applications.
- To have basic knowledge in GPS.

Unit I

Remote sensing

Definition Types of aerial photographs. Scale of photographs. Panchromatic, colour and infra-red films. colour and infra-red films. Elements of photo interpretation: tone, texture, pattern, shadow, drainage pattern and lineaments. Applications: Structural mapping and lithological mapping, groundwater exploration.

Unit II

Satellite Remote sensing

Electromagnetic Radiation, EMR spectrum, EMR interaction with atmosphere, EMR interaction with earth features. Atmospheric windows, Resolutions (Spectral, spatial, Temporal and Radiometric) Platforms and Sensors, Multi-spectral remote sensing data. Remote sensing satellites: Landsat, SPOT and IRS series of satellite data. Introduction to Hyperspectral remote sensing. Remote sensing Application in mineral exploration.

Unit III

Digital Image Processing- Digital Image- Digital Data Format- Image Processing Techniques - Radiometric correction- Geometric correction - Image Enhancement Techniques - Principal Component Analysis – Supervised classification - Unsupervised Classification.

Unit IV

GIS data model

Geographic Information System (GIS): Introduction, Definition, GIS Components. Data models: Vector Data model, Topology and Non-Topology models. Raster Data: Quad tree model, Run-length encoding. Raster and vector data conversion. Database management.

Unit V

GIS data analysis

Spatial Data analysis: Data editing, Data query, Logical operation, arithmetic operations. Map overlaying, DEM and its uses. GIS application in Natural resource mapping. GPS principle and applications.

Text / Reference Books

1. Anji Reddy, M. (2001), Text Book of Remote Sensing and Geographical Information Systems, BS Publication, Hyderabad .
2. Chandra A.M & S.K. Ghosh (2006), Remote Sensing & Geographical Information System, Narosa Publishing House, Chennai.
3. Curran,B (1985): Principles of Remote Sensing, Longman,London.Inc.
4. Drury, S.A. (1987). Image interpretation in Geology. Chapman and Hall.
5. Gupta, R.P. (2000) Remote Sensing Geology. Springer-Verlag. 356pp.
6. Ian Heywood, Sarah Cornelius and Steve Carver Parson, (2003), An Introduction to Geographical Information Systems (Edn) Singapore.
7. J. B. (1996) Introduction to Remote Sensing.622pp.
8. Jensen.J.R. (2005) Introductory Digital Image Processing-A Remote Sensing Perspective 3rd edition,pension prentice Hall, NJ,USA.
9. John Wiley., Pandey, S.N. (1987). Principles and applications of photogeology. Wiley Eastern, New Delhi.,
10. Lillesand, Thomas Kiefes (1979), Remote Sensing and Image Interpretation, John Wiley and sons
11. Sabins,F.F.Jr (1978):Remote sensing Principles and Interpretation, Freeman, Sanfrancisco sons, New York.
12. Shiv.N.Pandey (1987), Principles & Applications of Photo geology, Wiley Eastern Ltd.,

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	3	2	2	3	3	2	2	3	2	2	1
CO 2	3	3	2	2	3	3	2	2	3	2	2	1
CO 3	3	3	2	2	3	3	2	2	3	2	2	1
CO 4	3	3	2	2	3	3	2	2	3	2	2	1
CO 5	3	1	2	2	2	3	2	2	3	2	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying..

PRACTICAL-III
22UPAGP03 - ECONOMIC GEOLOGY AND MICROPALEONTOLOGY

Course objectives:

- This course will introduce physical, optical and chemical properties of various ore and industrial minerals.
- To understand how to identify the ores.
- It will also provide sound knowledge to evaluate the origin and occurrences of the ore and industrial minerals.
- To summarize the distribution of economic important minerals.
- Skill development of students in sample preparation techniques, systematic study of microfossils and exercises related biostratigraphy and environmental applications.

Course Outcomes

- The student will gain knowledge on identify the physical properties of industrial minerals and iron ores.
- The student will know the physical properties of Copper and Manganese ores.
- Discuss the physical properties of Lead and Zinc ores.
- Identify physical properties of sulphide ores.
- Analyze the Ore minerals quantitatively.
- On successful completion of the course, the student will be able to: - process the samples and separation of microfossils from matrix and identification of microfossils.

Economic Geology

Study of Industrial and ore minerals with special emphasis on physical, chemical characteristic mode of occurrences and uses.

Micropalaeontology

Techniques of separation of microfossils from matrix. Types of microfossils: Calcareous, Siliceous, Phosphatic and organic walled microfossils. Study of morphological characters of important benthic, planktic and larger foraminifera, ostracoda useful in ecology, paleoecology and biostratigraphy. Preparation of oriented sections of larger benthic foraminifera, nannofossils, radiolaria and diatoms. Exercises on Biostratigraphy and interpretations. Study of microfossil assemblages from various geological formations and interpretation of environment, geological age. SEM applications in Micropaleontology.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	3	3	2	3	3	2	2	2	2	1	1
CO 2	3	3	3	1	3	3	2	2	1	2	1	1
CO 3	3	3	3	2	3	3	2	2	1	2	2	1
CO 4	3	3	3	1	3	3	2	2	2	2	1	1
CO 5	3	3	3	2	3	3	2	2	2	2	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying..

PRACTICAL – IV
22UPAGP04 - HYDROGEOLOGY, REMOTE SENSING AND GIS

Course Objectives

- To familiarize water quality, samples have been collected from the field and estimate physical, chemical and biological parameters using different analytical techniques.
- To know the relationship among the different ions data obtained from the hydrogeology laboratory and projected graphically.
- Understand water quality and its suitability for domestic, irrigational and industrial purpose, the data have compared and correlate with BIS and WHO standards.
- To visually interpret the aerial photographs using stereoscopes for geological mapping. To visually interpret satellite image for lithology, structure, geomorphology, land use/ landcover mapping.
- To digitally process the satellite data for creation of composite images. To GIS component, creation of models and analysis.

Course Outcomes

- Executing geophysical survey in the field and understand different lithounits and find out water bearing horizons for locating water wells.
- To evaluate different aquifer parameters through pumping test.
- Interpret aerial photographs for geological mapping.
- Interpret and demonstrate the use of satellite data for various geological
- Applications and demonstrate digital image processing techniques using satellite images and develop GIS based interpretation and overlay outputs.

Hydrogeology

Estimation of chemical dissolved constituents*:* major, minor and traces in groundwater using standard laboratory techniques. *Diagrammatic representation of hydrochemical data:* bar, circular radial, multivariate schoeller diagram, four coordinate diagram, stiffs diagram, horizontal and vertical scale diagram. Plotting on maps-Piper, U.S. Salinity Laboratory diagram, Wilcox, Doneen, Gibbs and Durov plots. *Groundwater exploration techniques*: geophysical and geological methods of ground water exploration; *Pumping test:* time draw down and time recovery tests and evaluation of aquifer parameters. Water Balance method: Rainfall analysis (Isohyetal, Thiessen polygon, arithmetic method), Water level and Recharge estimation.

Remote Sensing and GIS

Aerial Photography: Stereovision Test, Pocket & Mirror Stereoscope - 3D Observation, Demarcation of marginal information, Identification photo Recognition elements. Interpretation of drainage pattern, landforms, rock types and structures.

Satellite Remote sensing: Decoding of Satellite data, Interpretation of satellite data for geomorphology, structure and lithology. Exposure to Digital Image Processing techniques, spectral plot for different features.

GIS: Scanning, Digitization, Preparation of Vector and Raster Image, Geo-Referencing. Overlay analysis. Network analysis, Proximity analysis. Digital Elevation Model.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	3	2	3	3	3	2	2	2	3	2	1
CO 2	3	3	2	3	3	3	3	1	2	2	1	1
CO 3	3	3	2	3	3	3	2	2	1	2	1	1
CO 4	3	2	2	3	3	3	2	2	1	2	1	1
CO 5	3	2	2	3	3	3	2	1	2	2	1	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying..

22UPAGC13 - MINING AND ENGINEERING GEOLOGY

Course Objectives

- To understand the basic fundamental concepts of various mining methods, their terminologies, and the type of sampling adopted, explosives used in the mine, and to have a basic knowledge about mine machineries
- The subject owes its growth to many civil structures which failed due to lack of geological application in the past. Therefore study of engineering geology is required.
- To provide the knowledge of geological investigation for site selection of engineering projects.
- To understand the rock type and their engineering properties, suitability of site conditions for Dam, tunnel, roads and highways.
- In order to construct a safe, long lasting and profitable benefit cost ratio structure the application of geological knowledge is very much in demand.

Course Outcomes

- Mining Geology provides a proper understanding on various mining terminologies and different methods practiced in alluvial, opencast and underground mining, according to the type of deposits. These studies also provide basic information on mining plans and mineral policies.
- Engineering Geology offers the basic concepts and its application in engineering practices.
- This course intends to make the students able to identify the suitable sites for different engineering constructions, identify potential geological hazards and manage various structures to prevent and control them.
- Selection of most suitable sites for any civil structure over or underground selection of suitable construction materials for any such project work.
- Ensuring that the structure will last long and serve the purpose for which it has been built and leading the way for infrastructural development of our country.

Unit I

Mining terminology, classification, geological factors considered for the selection of mining method viz.- Alluvial/Surface mining, Quarrying, Open-cast mining, and Underground mining methods; Geological conditions for - Types of openings, their position, shape and size - adits, inclines, shafts, levels, cross-cuts, winzes and raises. Types of drilling methods. Explosives - types, composition and its applications. Surface mining machineries.

Unit II

Alluvial mining: Types of placer mining, Panning, hydraulicking, Mechanical methods. Opencast mining Methods – bench cut, glory hole, strip mining. Factors considered for mechanization and transportation. Underground mining methods - board and pillar, room and pillar, long wall mining. Mine supports, Mine ventilation and Drainage. Mining hazards. Mines and Minerals Act. Factors in evaluating a mineral deposit; mine examination; theory and methods of sampling ; sampling calculations ; recoverable values

ENGINEERING GEOLOGY

Unit III

Scope of geology in civil engineering and mining industry. Various stages of engineering geological investigations for civil engineering projects. Engineering properties of rocks, rock discontinuities, physical characters of building stones, concrete and other aggregates. Use of remote sensing in engineering geology.

Unit IV

Geological considerations for the construction of dams and reservoir sites. Types of dams, dam foundation, rock problems. Geotechnical evaluation of tunnel alignments and transportation routes. Methods of tunneling; Classification of ground for tunneling purposes; various types of support.

Unit V

Geological considerations for the construction of roads/ highways and bridges. Mass Movements with special emphasis on landslide and causes of hill slope instability. Engineering consideration of seismicity, influence of geological condition on foundation and design of buildings, seismic resistant structure, earthquake problems in India. Engineering problems related to precautionary measures and mitigations of hazards; beach engineering.

Text / Reference Books

1. Arogyaswamy, R.N.P. (199)4. Course in mining Geology. Oxford IBH – New Delhi.,

2. Chandra, B. Krishna, J and Chandrasekaran, A. (1994). Elements of Earthquake Engineering. South Asian Publishers.

3. Deshmukh, R.T. (1993)High Technology in Drilling and Exploration, Oxford-IBH, New Delhi.,.

4. Gupta, H.K. and Rastogi, B.K. (1976).Elements of mining Technology Dhanbad publishers., Dhanbad.

5. Indian Bureau of Mines (1979) Dams and Earthquakes. Elsevier Scientific

Publishing Company.

6. Mineral exploration. IBM, Nagpur., Krynine, D.H. & Judd, W.R. (1998) Principles of Engineering Geology, CBS Edition.,
7. Mckinstry, H.E. (1980). Mining Geology, Prentice Hall, N.Y., Parbinsingh 1991.
8. Peters, W.C. (1987)A Text Book of Engineering & General Geology. Kataria & Sons.,.
9. R.W. (1997). Geological methods in Mineral Exploration and Mining, Chapman & Hall, London.,
10. Schultz, J.R. & Cleaves, A.B. (1951). Geology in Engineering, John Willey & Sons.,
11. Strahler A.N. and Strahler A.M. (1973). Environmental Geoscience - John Wiley & Sons., Venkatramiah, 1989 Engineering Geology. JohnWiley

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	3	2	3	2	3	2	2	2	1	1	1
CO 2	3	3	2	3	2	3	2	2	2	1	1	1
CO 3	3	3	2	3	2	3	2	3	1	2	1	1
CO 4	3	2	3	3	2	3	2	3	2	1	2	1
CO 5	3	2	2	3	2	3	2	2	1	1	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

ELECTIVE COURSES

22UPAGE01 - FUEL GEOLOGY

Course Objectives

- To educate about classification and petrography of coal
- To detail the various methods of utilization of coals
- To outline basic techniques of oil/gas production from coal
- To deliberate upon the generation and entrapment of oil
- To highlight the methods of oil exploration and distribution of petroliferous basins in India

Course Outcomes

- The course offers a detailed study about natural fuels like coal and petroleum their formation and distribution especially in sedimentary basins.
- To make the students aware about unconventional energy resources like shale gas CBM and Gas hydrates, it also deals with the exploration and extraction techniques used in petroleum industry.
- Students shall benefit to have basic ideas about formations, nomenclature in constitution of coal, Development of comprehensive knowledge of utilization of coals.
- A working detail of distribution of coals and coal industry in India, Sufficient idea of formation and entrapment of oil and gas.
- Elaborate understanding of oil exploration techniques and petroliferous basins of India.

Unit I

Coal Geology

Coal Petrology: Origin of Coal; Classification and optical properties of macerals and microlithotypes. Techniques and methods of coal microscopy. Classification of coal in terms of Rank, Grade and Type. Indian classification for coking and non-coking coals. International classifications (I.S.O. and Alpern's classification). Coalification process and its causes, geological and geographical distribution of coal deposits in India.

Unit II

Coalbed Methane: Introduction and early development; conventional natural gas resource; CBM resource; CBM vs. conventional reservoir; significance of coal rank in natural gas reservoirs; gas flow in coal deposits; problems in CBM mining; important natural gas resources in India. Coal petrology and its application in solving industrial and geological problems; preparation of coal for industrial purposes.

Unit III

Petroleum Geology

Petroleum Geology: Introduction. Origin of Petroleum (Inorganic and Organic theories) physical and chemical properties of petroleum; origin, migration and entrapment of petroleum; Reservoir rocks, clastic and non-clastic reservoir rocks, development and types of porosity in these rocks. Controls of permeability characteristics of reservoir; methods of petroleum exploration; oil well drilling and well logging; oil and gas fields of India, An outline of the oil belts of the world.

Unit IV

Methods of prospecting for oil and gas (geological modeling); Elementary knowledge of drilling and logging procedures, Coals, oil shales and other terrestrial source rocks for hydrocarbon generation, Basics of mud logging, MWD, LWD and interpretation. Onshore and offshore petroliferous basins of India. Indian Oil policy, Gas Hydrates: Exposure to gas hydrates and future prospective.

Unit V

Nuclear Geology: introduction; radioactive minerals as source of energy; nuclear fuel cycle; mineralogy, geochemistry and mode of occurrence of radioactive minerals; productive geologic horizons of atomic minerals in India; nuclear waste disposal. Geothermal energy: Principles of utilization of Earth's heat. Types of geothermal source, Applications, exploration, distribution of geothermal energy. Geothermal sources in India. Future scenario.

Text / Reference Books

1. Levorsen, A. I., & Berry, F. A. (1967). Geology of petroleum (Vol. 724). San Francisco: WH Freeman.
2. Chandra, D., Singh, R.M. Singh, M.P., (2000): Textbook of Coal (Indian context). Tara Book Agency, Varanasi.
3. Singh, M.P. (Ed.) (1998): Coal and organic Petrology. Hindustan Publishing Corporation, New Delhi.
4. Scott, A.C., (1987): Coal and Coal-bearing strata: Recent Advances. The geological Society of London, Publication no. 32, Blackwell scientific Publications.
5. Stach, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichumullelr, M. and Teichmuller R., (1982): Stach Textbook of Coal petrology. GebruderBorntraeger, Stuttgart.
6. Holson, G.D. and Tiratso, E.N., (1985): Introduction to Petroleum Geology. Gulf Publishing, Houston, Texas.
7. Tissot, B.P. and Welte, D.H., (1984): Petroleum Formation and Occurrence, Springer – Veralg.
8. North, F.K., (1985): Petroleum Geology. Allen Unwin.
9. Selley, R.C., (1998): Elements of Petroleum Geology. Academic Press.
10. Durrance, E.M. (1986): Radioactivity in Geology-principles and application. Ellis Hoorwool.
11. Dahlkamp, F.J., (1993): Uranium Ore Deposits. Springer Verlag.

12. VBoyle, R.W., (1982): Geochemical prospecting for Thorium and Uranium deposits, Elsevier

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	1	1	2	3	2	1	3	2	2	1
CO 2	3	1	1	1	2	3	2	2	2	1	2	1
CO 3	3	1	1	1	2	3	2	2	3	1	1	1
CO 4	3	2	1	1	2	3	2	2	2	2	1	1
CO 5	2	2	1	1	2	3	2	2	2	2	2	1

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding, K3- Applying

22UPAGE02 - ANALYTICAL AND INSTRUMENTATION TECHNIQUES

Course Objectives

- This course is designed to give the student an understanding in the operation and care of instruments, principles and theory of instrument analysis, the correct operation of chemical instruments.
- To introduce the student to the techniques of troubleshooting instruments in the chemical laboratory, emphasize the safe use of chemical instrumentation.
- To teach the student to solve problems related to the use of chemical instruments.
- To stress proper record keeping in the chemical laboratory and plant.
- To encourage library use as applied to instrumental analysis

Course outcomes

- Gain knowledge on the application, advanced instruments to be used for analysis of water, rocks and minerals.
- Student understand the principles of how to prepare a sample for different analysis.
- Understand the effects of different constituent in a process outcome.
- Decide the dominate frequency characterize the substance from spectrum analysis.
- Perform experimental.

Unit I

Introduction to analytical chemistry: Analytical Instrumentation in Geology, Qualitative and quantitative analysis. Classification of methods. Types of instrumental analysis. Various instrumental techniques and laboratory safety.

Unit II

Laboratory techniques: Laboratory operation and practices. Units of measurements. Laboratory notes. Errors and evaluation. Determination of accuracy. Statistical evaluation of data interpretation techniques.

Unit III

Petrological microscopes: Principles, Parts, Operation and application of Petrological microscope, Ore microscope and Scanning Electron Microscope (SEM). Preparation of thin section. Preparation of rock powder for chemical analysis. Rock digestion through acid treatment, Rock digestion through fusion with alkali salts.

Unit IV

Geochemical sampling techniques: Sample preparation and Geological reference materials, Portable analytical instruments Sampling methods and principles, Types of sampling, sampling interval. Heavy mineral separation methods. Flame photometer and UV spectrometer: Basic principles, Parts and operation and mechanism. Chromatography: Introduction to Chromatographic techniques, Liquid chromatography, Gas chromatography, Applications of chromatography, High Performance Liquid Chromatography (HPLC) and Neutron activation analysis.

Unit V

Instruments used for geochemical analysis: Basic concept and techniques of Atomic Absorption Spectrometer (AAS). Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES). X-Ray Diffraction (XRD), X-Ray Fluorescence (XRF) and Differential Thermal Analysis (DTA). Electron probe micro-analyzer (EPMA). Infrared and Raman Spectroscopy, Fourier-transform infrared spectroscopy (FTIR).

Text / Reference Books

1. Dana,E.S.,(1955),Text book of Mineralogy, John Wiley., Deer,
2. W.A., Howie, R.A. and Zussman, J., (1996), The Rock forming Minerals-Longman.,
3. Flint,Y.,(1970), Basic crystallography, Mid Publishers.,
4. Francis Rouessac and Annick Rouessac., (2007), Chemical Analysis (Modern Instrumentation Methods and Techniques) John Wiley & sons, 574p.,
5. Hutchinson, C.S., (1974), Laboratory Handbook of Petrographic Techniques-John Wiley.,
6. Kerr,P.F.,(1959), Optical Mineralogy, McGraw Hill.,
7. Klein, C. and Hurlbut, Jr. C.S., (1993), Manual of Mineralogy-John Wiley.,
8. Madhu Arora.,(2008),Analytical chemistry-Himalaya Publishing House, Mumbai., Phillips,
9. Wm, R. and Griffen, D.T., (1996), Optical Mineralogy-CBS Edition.,
10. Putnis, Andrew, (1992), Introduction to Mineral Sciences-Cambridge University Press.,
11. Spear, F.S. (1993), Mineralogical Phase Equilibria and Pressure-Temperature-Time paths-Mineralogical Society of America Publ.
12. Venkateswaran. S (2010) Handbook of analytical Hydrogeochemistry, TNBH publishers, Chennai, Tamilnadu. ISBN 978-81-7511-006-9.

Outcome MappingSe

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	3	3	2	3	1	2	2	1
CO 2	3	2	2	3	3	3	1	2	1	2	2	1
CO 3	3	2	2	2	2	3	2	2	2	1	1	1
CO 4	3	2	2	2	1	3	2	1	1	1	1	1
CO 5	3	2	2	3	2	3	2	2	1	1	2	1

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

22UPAGE03 - ADVANCED SURVEYING TECHNIQUES

Course Objectives

- To impart knowledge about the concept various surveying types.
- To acquaint students with knowledge of aerial photography.
- To discuss total station surveying.
- To explain the GPS and DGPS surveying.
- To know about the modern surveying techniques.

Course Outcomes

- Students will acquire knowledge in advanced surveying techniques
- Understands the modern survey equipment and tools
- Exposure on the lines of global level recent technology
- Understands about the procedures of survey.
- Apply the knowledge on modern software.

Unit I

Introduction to surveying: Reconnaissance, Rout surveys for highways, railways and waterways, simple, compound, reverse, transition and vertical curve, setting out methods, hydrographic surveying, tides, MSL, Sounding methods, measurement of current and discharge, Tunnel alignment and setting out, Settlement and Deformation studies.

Unit II

Aerial Surveying: Introduction, Uses, Aerial photographs, Definition, Scale of vertical and tilted photograph (simple problems), Ground co-ordinates (simple problems), Relief Displacements (Derivation), Ground control, Procedure of aerial survey, overlaps and mosaics, Stereoscopes, Derivation Parallax.

Unit III

Total Station Surveying: Classification – basic measuring and working principles of an Electro – optical and Microwave total station- sources of errors in Electro – optical and Microwave total station – Care and Maintenance of total station – trilateration – Applications.

Unit IV

GPS & DGPS Surveying: Basic concepts – Space, Control and User segments – Satellite configuration – Signal structure – Orbit determination and representation – Anti spoofing

and selective availability – hand held and geodetic receivers – Field work procedure – Data processing Applications.

Unit V

Modern Surveying: Remote Sensing: Introduction, Principles of energy interaction in atmosphere and earth surface features, Image interpretation techniques, visual interpretation. Digital image processing, Global Positioning system. Geographical Information System: Definition of GIS, Key Components of GIS, Functions of GIS, Spatial data, spatial information system Geospatial analysis, Integration of Remote sensing and GIS and Applications Geology. Drone Survey techniques.

Text / Reference Books

1. James M. Anderson and Edward M. Mikhail, "Surveying, Theory and Practice", 7th Edition, McGraw Hill, 2001.
2. Bannister and S. Raymond, "Surveying", 7th Edition, Longman 2004.
3. Alfred Leick, GPS satellite surveying, John Wiley & Sons Inc., 3rd Edition, 2004.
4. Laurila, S.H. Electronic Surveying in Practice, John Wiley and Sons Inc, 1993.
5. Roy S.K., "Fundamentals of Surveying", 2nd Edition, Prentice Hall of India, 2004.
6. Arora K.R. "Surveying Vol I & II", Standard Book House, 10th Edition 2008.
7. Guocheng Xu, GPS Theory, Algorithms and Applications, Springer – Verlag, Berlin, 2003.
8. Seeber G, Satellite Geodesy, Water De Gruyter, Berlin,1998.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	2	3	2	2	2	1	2	1
CO 2	3	2	2	3	3	3	2	1	2	2	2	1
CO 3	3	3	2	2	2	3	2	2	3	1	1	1
CO 4	3	3	2	1	2	3	2	1	3	2	1	1
CO 5	3	2	2	2	2	3	2	2	2	2	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and C2O-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

22UPAGE04 - METEOROLOGY AND CLIMATE CHANGE

Course Objectives

- To understand the meteorology and earth radiation balance.
- To know the behavior of meteorological parameters.
- To learn the concept of EL Nino impact and weather forecasting.
- To study the climate changes over geological period and its impact.

Course Outcomes

- Define meteorological phenomena and evaluate radiation balance in earth.
- Demonstrate Meteorological parameters like atmosphere, temperature and Precipitation.
- Explore El Nino impact and interpret weather forecasting.
- Appraise climate change and predict it from geological records.
- Explore impact of climate change.

Unit I
Meteorology and radiation

Meteorology: introduction, definition, scales in meteorology, branches and applications. Earth Radiation balance: Sun's Energy output, Incoming radiation, Energy spectra of sun and earth, Insulation, Insulation over the globe, insulation losses in atmosphere, long wave radiation, Global radiation balance, Solar energy.

Unit II
Atmosphere, temperature and precipitation

Atmosphere: Composition and structure of atmosphere, Layered structure of atmosphere. Temperature: Introduction, factors influences air temperature, Surface temperature, air temperature, daily cycle of temperature, annual cycle of temperature, urban heat island. Precipitation: Precipitation processes, orographic precipitation, convection precipitation, frontal type of precipitation.

Unit III
El Nino and weather forecasting

El Nino: Introduction, upwelling. El Nino La Nino events and consequences: unusual weather and rainfall, sea surface temperatures, atmospheric consequences, economic consequence. Detection and prediction of El Nino. Weather forecasting: Persistence, trends, climatology, analog and numerical weather prediction methods. Forecasting surface features: Anti cyclone, cyclone, cold front and warm fronts. Forecasting precipitation: effect

of frontal lifting, effect of moisture, rain and snow.

Unit IV
Climate change

Introduction, definition. Classification of climate; Koppen's, Bergeron, Thornthwaite's and Strahler classification. Climate change, Palaeoclimatology, Climatic changes through geological time, Geological records of climate, Assessing climate change, Human intervention on climate change. Greenhouse effect, greenhouse gases. Global warming – Causes and consequences of global warming; Effect of global warming on Indian monsoon systems, Volcanic eruptions and aerosols, Ozone hole; Acid rains, Nuclear winter, IPCC, Montreal Protocol, Kyoto Protocol and Copenhagen Protocol.

Unit V
Causes and impact of climate change

Causes of climate change: Astronomical theories, Plate Tectonism, Ocean circulation pattern, Changes in compositions of atmosphere, Changes in solar radiation. Impact of climate change: Rising of CO2, impact on atmospheric circulation & weather pattern, biosphere, hydrosphere, sea level changes, Adaptation provinces.

Text / Reference Books

1. Alan .H. Strahler and Arthur N.Strahler 1992.Modern Physical Geography Fourth Editions John Wiley &Sons.In.p638.,

2. Alan Strahler and Arthur Strahler (2002). Physical Geography, 2nd edition John Wiley & Sons Inc.P748.

3. Byers(2005), Meteorology, The Encyclopedia Britannia 15th Ed.

4. Dorothy J.Meeritts and Andrew De (1997)Wet & Kirsten Menking, Environmental Geology – W.H.Freeman and Company, New York ,.,

5. Horace General, (1994)Meteorology New York Mc Graw Hill.

6. John.M. Das (1995)The Monsoons, National Book house Trust, New Delhi (Third Edition).,

7. Rev.Fr.S.Ignacimuthu (2010) Environmental Studies, MJP Publishers,

8. Travis Hudson (2012) Living with Earth- An Introduction to Environmental Geology, PHI Learning Private Ltd,

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	2	3	2	2	3	2	2	1
CO 2	3	1	2	3	1	3	1	1	2	2	1	1
CO 3	3	2	2	3	2	2	1	2	2	3	1	1
CO 4	3	1	2	3	1	2	1	1	2	1	2	1
CO 5	3	1	2	3	2	2	2	1	2	2	1	1

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding, K3- Applying

22UPAGE05 - GEO-STATISTICS

Course Objectives

- This course provides the learners to have an idea about the nature and variabilities of Earth Science Data sets.
- The course aims to introduce the different statistical operations done on such data enabling estimation, prediction, simulation and modeling.
- Knowledge of statistical procedures is inherent in data analysis and management.

Course Outcomes

- This course will help the students in the skill of data handling and data management.
- The students will be able to correlate between variables and use statistical procedures as estimators.
- Students have expertise developed in Data processing, data interpretation, statistical testing and modeling needed for a professional career in Geosciences.

Unit I

Basic Statistics – Classification and presentation of statistical data, Characteristics of Normal distribution, measures of central tendency and dispersion, correlation, Least square method and regression analysis, probability and probability distributions, concept of population and sample, Sampling and sample distributions

Unit II

Central limit theorem; Concept and methodology of Hypotheses Testing and its application in geology - student's t test, F test, $\chi 2$ test, ANOVA (one way)

Unit III

Concept of regionalized variable- semi variance & semivariogram, kriging, Basic spatial interpolation: nearest neighbors, inverse distance, trend surfaces, Introduction to simulation methods

Unit IV

Analysis of sequences of data: Markov chains, auto correlation and cross correlation, Univariate statistics: Measures tools of Location and Spread, Mean, median, variance, Standard Deviation. Univariate Plots: Histogram, Probability Density Function (PDF), Cumulative Density Function (CDF). Bivariate Statistics: Bivariate Data Display: Scatterplot or Cross plot, Bivariate Measures (Covariance, Correlation Coefficient).

Unit V

Analysis of multivariate data, Map analysis. Fractals in geology. Linear Regression, Declustering.

Text / Reference Books

1. Schabenberger, O. and Gotway, C. (2005) Statistical Methods for Spatial Data Analysis Chapman & Hall/CRC.
2. Peter J. Diggle, Paulo J. Ribeiro, Jr (2007) Model-based geostatistics, Springer.
3. Cressie, N. (1993). Statistics for Spatial Data (Revised Ed.). John Wiley & Sons, Inc.
4. Chiles, J. P. and Delfiner, P. (1999) Geostatistics: Modeling Spatial Uncertainty Wiley.
5. Davis, J.C., Statistics and Data Analysis in Geology, 3rd Edition, John Wiley & Sons, Inc.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	2	3	2	2	3	2	2	1
CO 2	3	1	2	3	1	3	1	1	2	2	1	1
CO 3	3	2	2	3	2	2	1	2	2	3	1	1
CO 4	3	1	2	3	1	2	1	1	2	1	2	1
CO 5	3	1	2	3	2	2	2	1	2	2	1	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

22UPAGE06 - GEO-HERITAGE AND GEO-TOURISM

Course Objectives

- The concept of developing geoparks and geotourism will be introduced and a need for making laws to preserve them would be emphasized
- An attempt will be made to familiarize the above fact in the mind of common man.
- The unique geological and geomorphologic features distributed throughout the country that constitutes its geoheritage.
- The development process obliterates many of these features and this loss necessitates.

Course Outcomes

- The preservation of representative and spectacular features which explain the geological process over geological time Geoheritage has been a neglected feature in the conservation landscape of India.
- Due to the lack of awareness and stringent laws little efforts are being made to preserve these national treasures.
- Geological monuments little else has been done to protect these marvels of the nature. There is an immediate need to make the public aware of the country's national treasures.

Unit I

Introduction and importance of Geodiversity, Geoheritage, Geoconservation; Geoparks and Geotourism; History of the concept of Geoheritage.

Unit II

Geological outcrops and society; Threats to geodiversity; Conservation, protection, maintenance of geological sites and related features of National importance; Conservation of geosites as a tool to protect geoheritage.

Unit III

Potential geoparks and geosites in India; Rajasthan, Odisha, Karnataka, Andhra Pradesh, Madhya Pradesh, Telangana, Tamil Nadu, Kerala, Gujarat, Himachal Pradesh

Unit IV

UNESCO geoparks, Geopark networks across the globe; Geotourism and National geological Monuments.

Unit V

Guidelines for selection of Geosites; Geoheritage laws, Role of local, state and national governments; Current status of Geoheritage protection in the country; Global geoheritage

and protection laws.

Text / Reference Books

1. A Monograph on National geoheritage monuments of India, Indian National Trust for Art and Cultural Heritage, Natural Heritage Division, New Delhi
2. Ranawat, P. S., George, S., 2016 Potential Geoheritage & Geotourism Sites in India International Journal of Scientific and Research Publications, Volume 9, Issue 6, June 2019
3. Ezzoura Errami, Margaret Brocx (Ed.) 2009. Geoheritage, Geoparks and Geotourism Conservation and Management Series Springer. P 268.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	2	3	2	2	3	2	2	1
CO 2	3	1	2	3	1	3	1	1	2	2	1	1
CO 3	3	2	2	3	2	2	1	2	2	3	1	1
CO 4	3	1	2	3	1	2	1	1	2	1	2	1
CO 5	3	1	2	3	2	2	2	1	2	2	1	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

22UPAGE07- ENVIRONMENTAL GEOLOGY AND DISASTER MANAGEMENT

Course Objectives

- To understand the interaction of humans with the geological environment
- Familiarize students of challenges of environment in the urban sector.
- To teach practical contribution that geologist can make in managing human interaction with the physical environment.
- To provide the knowledge on geology and environment, impact due to mineral, soil and land degradation.
- Expose the students to assess various geological environments like terrestrial, aquatic, etc., provide knowledge and guidelines to assess and plan various environmental issues.

Course Outcomes

- The student will learn about the concepts of environmental geology and gain knowledge on managing geological resources.
- Understand the role of plate tectonic in causing Earth quake and how this understanding can aid the assessment of seismic hazard.
- Appropriate usage of the geological environment for waste disposal.
- Recognition of natural hazards and mitigation of their human impacts.
- The students gain knowledge on various environmental problems.

Unit I

Environmental Geology

Earth's place in space. Fundamentals concepts of Environmental Geology: Human Population Growth - Sustainability - Earth as a System - Hazardous Earth Processes - Scientific Knowledge and Values. Internal Structure of Earth and Plate Tectonics - Plate Tectonics & Environmental Geology. Minerals and Rocks. Ecology and Geology. Soil and Water Pollution and Treatment, Solid Waste Management, Hazardous Chemical Waste Management, Radioactive Waste Management, Geology and Environmental Health.

Unit II

Natural Hazards

Hazards, Disasters, and Nature Processes - *Evaluating Hazards:* History, Linkages, Disaster Prediction, and Risk Assessment - Fundamentals principles concerning Nature Hazards - Human response to Hazards - Global Climate and Hazards - Population Increase, Land - use

Change and Nature Hazards.

Unit III
Volcanoes and Earthquakes

Earthquakes: Magnitude and intensity. Plate boundary related Earthquakes - Earthquake processes (Faulting, Tectonic group). Earthquake shaking (seismic waves, seismograph) - Earthquake cycle - Earthquake caused by Human Activity-Effects of Earthquakes – Tsunami - Earthquake risk and Earthquake prediction - Earthquake warning system. *Volcanic activity* - Volcanic Hazards, Forecasting volcanic activity. *Landslides:* Human use Landslide - Minimising the Landslide Hazards- Perception of Landslides,

Unit IV
River, Flooding, and Coastal Hazards

Rivers and Flooding: Sediments in River - River velocity, Discharge, Erosion, and Sediments deposition- Effects of Land - use Change - Channel Pattern & Floodplain Formation - River Flooding - Urbanisation & Flooding- The Nature and Extent of Flood Hazards - Adjustments to Flood Hazards - Perception of Flooding. *Coastal processes:* Erosion - Coastal Hazards & Engineering structure - Human activity and Coastal erosion - Perception of and Adjustment to Coastal Hazards.

Unit V
Resources and Pollution

Water Resources: A brief global prospective of surface water – Groundwater - Interactions between surface water and Ground water - Desalination - Water Managements - Water and Ecosystem. *Water Pollution*: Selected Water Pollutions – Oxygen - Demanding Waste - Pathogenic Organisms - Nutrients - Toxic Substances - Synthetic Organic Chemicals – Heavy Metals - Surface Water Pollution and Treatment- Point Source and Non-point Source - Ground water Pollution and Treatment. *Mineral resources*: Mineral of Human use - Geology of Mineral Resources - Environmental Impact of Mineral Development – Recycling of Mineral Resource Energy. Geo thermal Energy.

Text / Reference Books

1. Bennett, M. R. B., Doyle, P. (1997) Environmental Geology By. John Wiley & Sons, New York., Rekha Ghosh and D. S. Chatterjee. Environmental Geology – Geo ecosystems Protection in Mining Areas. Capital Publ. Co., New Delhi.,

2. Carla W. Montgomery WCH Wm.C (1989). Environmental Geology, Brown Publishers Dubuque, Iowa

3. Chiras, D.D, (1989) Environmental Science – A framework for decision making, Addison – Wesley Publishing Company. New York.,

4. Davis, N. et.Al., (1976)Environmental Geosciences, John Wiley and sons, New York.,

5. Detwler, T.R,(1971) Man's Impact on Environment, McGraw Hill

6. Keith, L. H. (1996) Principles of Environmental Sampling. ACS Professional Reference book, Amer. Chem. Soc., Washington DC.

7. Khoshoo, T. L. (1988) Environmental Concerns and Strategies By. Ashish Publ.New Delhi.,

8. Montgomery, C.W., (1989) Environmental Geology, Brown publications.,

9. Ray, P. K. and Prasad, A. K. (1995) Pollution and Health. Wiley Eastern Publ., New Delhi.,

10. Strahler, A.N., (1973) Environmental Geology, John Wiley and sons, New York.,

11. Subramanian, V. (2002), A Text book in Environmental Science, Narosa Publishing House, New Delhi

12. Valdiya, K. S. (1987) Environmental Geology - Indian Context . McGraw Hill Publ.,

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	1	2	3	3	3	1	3	2	2	1
CO 2	3	2	1	2	3	3	2	2	3	1	2	1
CO 3	3	1	1	1	3	3	2	1	2	1	1	1
CO 4	3	1	2	1	3	3	2	3	2	2	1	2
CO 5	3	1	2	2	3	3	3	3	2	1	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

22UPAGE08 - MARINE GEOLOGY

Course Objectives

- To teach the ocean geological resources exploration and exploiting methods, instrumentations, ocean environment, ocean geology.
- To gain knowledge on marine environment, morphology, processes, classification and marine resources.
- To learn about the basic concept of oceanography.

Course Outcomes

- Understand the ocean morphology and formation.
- To know about the mineral resources of marine environment.
- Preparation man power to address ocean resources and environment.
- The course covers marine environments, depositional and erosional processes, origin of oceanic basins and morphological features, and mineral resources

Unit I
Introduction

History of Marine Geology ,Waves, tides, currents, turbidity currents, long shore currents, rip currents, circulation, Wave Action: wave reflection, refraction and diffraction – Seiche and tsunamis – Coastal Zone Morphology (Estuaries, deltas, bays, raised beaches, features of wave erosion and deposition, tombolos, mud banks) – Deep sea Morphology (Continental shelf, Continental slope, abyssal plains, sea mounts, guyots, fracture pattern.

Unit II
Marine Processes and Geomorphic features

Littoral processes - Evolution of headlands and bays - Beaches - Raised and sunken features – Evolution and classification of sea coasts and shore lines. Terrestrial-lacustrine-shallow marine-deep sea - siliciclastic versus carbonate sedimentation - deep ocean silica burps - shelf-to-basin transport phenomena turbidites and gravity flows – Submarine groundwater discharge.

Unit III
Seafloor Tectonics

Causes of marine regression and transgression – Description of important regressions and transgressions in the geological past – Eustasy –Origin and distribution of ocean basins – Palaeoceanography- Ocean floor tectonics: Characteristics of Oceanic Plate – Geologic processes along Oceanic Plate boundaries – Seafloor Spreading – Evidence - lithospheric plates –divergent plate boundaries – Trenches as convergent plate boundaries – Subduction zones – Transform fault boundaries

Unit IV Marine Sediments and Marine Geochemistry

Marine sedimentation – Sources, types and distribution of marine sediments – Transport of sea bottom sediment - Rate of deposition – Mineral resources. Marine phosphorite, glauconites, barium sulphate concretions, Polymetallic nodules – Gas hydrates - Beach placers. Terrigenous, Biogenic and Chemical Types – Placer Deposits. Distribution of temperature, salinity and density.

Unit V Applied Marine Geology

Trenches and Submarine Canyons – Bengal Fan. Biogenic structures: Reefs of corals and algae Mid-ocean ridges, and the structure of the oceanic crust - Coastal processes and the structure of continental margins. Coastal zone regulation in India – India as Pioneer Investor in Seabed mining. Seafloor geologic process – Volcanism and seismicity. Ocean Circulation, Proxies of ocean change, Glacial Interglacial Changes in the Ocean, Marine Stratigraphy.

Text / Reference Books

1. King, C.A.M., (1975). Introduction to marine Geology and Geomorphology. Edward Arnold, London.
2. Radhakrishnan, V., (1996). General Geology V.V.P. Publishers, Tuticorin.
3. Seabold, E. and Berger,W.H. , (1982). The Sea Floor, Springer Verlag. Kuenen, Ph.H., 1950. Marine Geology. John Wiley and Sons.
4. Shepard, F.P., (1978). Geological Oceanography, Heinmann, London.
5. Harper and Row. Kurekian, K.K., 1990. Ocean, Prentice Hall. New Jersey.
6. Svedrup, J.F., (1969). The Ocean, A Scientific American book, W.H. Freeman and company, San Francisco.
7. Kennett,J.P. (1982). Marine Geology. Prentice Hall. New Jersey.
8. Weisberg,C.P. (1979). Oceanography. McGraw Hill. New York.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	1	2	3	3	2	2	2	2	1	1
CO 2	3	1	2	1	2	3	2	2	2	2	2	1
CO 3	3	2	1	2	2	3	1	1	2	1	1	1
CO 4	3	3	1	2	3	3	2	2	3	1	1	1
CO 5	3	2	1	2	3	3	2	2	3	1	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

SUPPORTIVE COURSES

22UPGS01 - EARTH AND ENVIRONMENT

Course Objectives

- To explore the fundamental interactions of the geosphere, hydrosphere, atmosphere and biosphere.
- The unit is designed to provide a strong scientific foundation for understanding and contextualizing studies of the environment, human impacts and sustainable practice and management of resources.

Course Outcomes

- The interaction between the Earth's spheres, relevant processes and environmental changes.
- Knowledge and understanding Recapitulate processes in the different spheres
- Describe the connections and feedback between the Earth's spheres Explain the connection between Earth System processes and global environmental changes
- A basic understanding of the Earth as an holistic system knowledge of the main components of the Earth system and their interactions
- The interactions between biological, chemical, and physical processes that shape and define the Earth System.

Unit I
Space Science

Introduction to various branches of Earth Sciences. Solar System, Age of the Earth, Origin of Solar system. Meteors and Meteorites. Earth Dynamics : Interior of the Earth, Composition of the Earth, Seismic waves, Seismograph, Plate Tectonics, Basics of Earthquake Engineering, Landslides, Volcanoes.

Unit II

Geological Oceanography:

Hypsography of the continents and ocean floor –continental shelf, slope, rise and abyssal plains. Physical and chemical properties of sea water and their spatial variations. Residence times of elements in sea water. Ocean currents, waves and tides, important current systems, thermohaline circulation and the oceanic conveyor belt.

Unit III
Hydrogeology

Hydrogeology: Water table- Aquifer- Groundwater fluctuations and groundwater

composition, Hydrological cycle. Glaciology: Glacier types, Different type of glaciers, Landforms formed by glacier. Petrology - Geological bodies and their structures: Rock, mineral, batholiths, dyke, sill, fold fault, joint, unconformity.

Unit IV

Earth's Atmosphere:

Structure and composition of atmosphere, Atmospheric circulation, Geological work of wind, Greenhouse effect and global warming, Carbon dioxide sequestration. Steps to maintain clean and pollution free atmosphere with governing laws, precautionary measures against disasters.

Unit V

Environmental Earth Sciences: Properties of water; hydrological cycle; water resources and management. Energy resources, uses, degradation, alternatives and management; Ecology and biodiversity. Impact of use of energy and land on the environment. Exploitation and conservation of mineral and other natural resources. Natural hazards. Elements of Remote Sensing.

Text / Reference Books

1. Holme's Principles of Physical Geology. (1992). Chapman & Hall.
2. Emiliani, C, (1992). Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	1	1	2	3	2	1	2	2	2	1
CO 2	3	1	1	1	2	3	2	2	2	2	2	1
CO 3	3	1	1	1	2	3	2	2	2	1	1	1
CO 4	3	2	1	1	2	3	2	2	3	1	1	1
CO 5	3	2	1	1	2	3	2	2	2	1	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

22UPGS02 – WATER RESOURCES MANAGEMENT

Course Objectives

- To know about the nature and occurrence of water, its spatial and temporal variability, quantity and quality considerations and human influence.
- To define the water resources endowment on which development and use of water resources must be planned.
- To develop a sound foundation on dynamics of water in the nature and human interferences.
- To develop wider perspectives on integrated water resources management.

Course Outcomes

- Appreciate the circulation of water in earth-atmosphere system and the hydrologic processes over a river basin and emerging quality and quantity concerns thereto.
- Quantify the occurrence and variability of rainfall, runoff, flood and sediment transport processes.
- Quantify the occurrence and distribution of groundwater to plan potential groundwater usage.
- Analyze the human interferences on hydrologic processes and the resulting consequences in terms of quantity and quality.

Unit I

Introduction: Definition, concepts of watershed, major objectives of watershed management, effects of watershed on community, ecosystem, Monitoring and evaluation of watershed.

Unit II

Principles of watershed management: Delineating the watershed. natural processes at work in watershed, common elements of watershed management, multidisciplinary approach in watershed management, participatory resources mapping and appraisal, benefits of watershed approach.

Unit III

Degradation agents in watershed: Flood, drought, fire, wind storms, erosion and deposition. Climate change. Glacial movement, Tectonic activity. Volcanic eruption. Human–induced changes. Impact of the degradation of watersheds in hydrology.

Unit IV

Engineering measures for soil conservation: Rainfall parameters. Types of soil erosion. contour bunding, Surplussing structures contour and straggled trenching, gully control structures, graded bunding, bench terracing, land leveling and grading.

Unit V

Water Conservation and Harvesting: Water conservation methods for crop land, Treatment of catchments. *Rainwater harvesting structures:* Check dam, farm pond, percolation tank, basin, ditch and furrow, channel, flooding, irrigation, subsurface dyke, Nalla bund and pit methods. Ecosystem assessments, Environmental flows, Future freshwater challenges, Eco tourism, Social and political issues of water use - Sustainable Ecosystems - Environmental governance.

Text / Reference Books

1. Rajora,R.,(1998), Integrated Watershed Management, Rewat Publications, New Delhi.

2. Tideman.E.M., (1996), Watershed Management: Guideline for Indian Conditions, Omega, Scientific Publishers,372p. New Delhi

3. Lal.S., (2004), Watershed, Development, Management and Technology, Mangal Deep Publications,358p.

4. Paranjape,S.et.al.,(1998), Watershed Based Development: A Source Book, Bharat Gyan Vigyan Samathi, New Delhi.

5. Suresh,R.,(2002), Soil and Water Conservation Engineering, Standard Publishers and Distributors, Delhi.

6. Kakade,B.K.,(2002), Soil and Water Conservation Structures in Watershed Development Programs ,BAIF Development Research Foundation, Pune.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	1	1	2	3	2	1	2	2	1	1
CO 2	3	2	1	1	2	3	2	1	2	2	1	1
CO 3	3	2	1	1	2	3	2	2	3	2	2	1
CO 4	3	2	1	1	2	3	1	2	2	2	1	1
CO 5	3	2	1	1	2	3	2	2	2	1	2	1

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

22UPGS03 – GEMMOLOGY

Course Objectives

- To learn and to examine the nature, quality, rarity of gemstones.
- To understand the physical and optical properties of gemstones.
- To summarize the origin, classification of gems.
- To give an idea about the gem testing instruments.
- To gain knowledge and to provide skills to become a successful gemologist.

Course Outcomes

- The course is focused on a comprehensive learning in gemology.
- Understands the formation, classification to final grading and evaluation.
- Apply Basic gemological techniques will be learned from this course
- Knowledge and order to identify gemstones and simulants.
- The students will acquire skills which will be useful to them in gem industry.

Unit I

Introduction to Gems - Basic properties of gems. Formation of gem stones. Nature of gem material: quality necessary in gems-beauty, rarity, durability. Distinction between crystalline, amorphous and metamict materials. Crystal form and habit. Classification of gem stones. Observations with hand lens (10x)-importance and uses. Units of measurement: metric scale, carat, pearl and grain.

Unit II

Nature of crystals: distinction between crystalline and amorphous material, crystal symmetry, Twinning, parallel growth, crystal form, crystal habit, seven crystal system. Identification of rough stones. Imitation stones.

Unit III

Physical properties: hardness its applications in gemmology and limitations. Cleavage, Fracture, parting, and their importance in gemology and lapidary work. Specific gravity-utility and determination by hydrostatic weighing, heavy liquids, floation and pycnometer. Inclusions and other features of gemstones. Generalities, Description, Properties and Identification of Biogenic Gem Materials.

Unit IV

Optical properties: The electromagnetic spectrum, reflection and its importance in gemology-lustre, aventurescence, sheen, chatoyancy, asterism, luminescence, play of colors, labradorescence, inclusions etc.. Laws of refraction, refractive index (R.I), total reflection-in design of refractometer. Construction and use of refractometer. Polariscope-construction and use in gemmology. Dichroscope-construction, use of Chelsea colour filter, Infra-red

ultraviolet and x-rays in gem identification.

Unit V

Enhancement and treatments- enhancement methods - coloured and colourless impregnation, dyeing, bleaching and its identification. Methods of treatment – laser drilling, irradiation, heat treatment, surface modifications, diffusion treatment and its identification. Composites - types, classification and identification.

Text / Reference Books

1. Karanth K.V.(2000),Gem and gem industry in India, Memoir 45,Geological Society of India, Bangalore.,
2. Anderson,B.W(1990).Gem testing (10th edition),Butterworth Scientific, London.,
3. Babu,T.M.(1998) Diamonds in India. Geological society of India, Bangalore.,
4. Hall,C.(1994).Gemstone, Dorling Kingsley, London.
5. Deer,W.A., Houre,R.A abd Zussman.S.(1992). An introduction to rock forming minerals, ELBS, London.
6. Kerr, P.F.(1997).Optical mineralogy,4th Ed. McGraw Hill Book & Co New York., Gemmology 2nd Ed.-Peter Read (1991) Butter worth-Heinemann Ltd.Lundu., Gems 5th Ed. Peter Read. Butterworth, London
7. Richard Laddicoat (1987), Hand book of gem identification- G.I.A.
8. Santa Monica., Edward Gubelin (1986) Photo Atlas of Including in Gem Stones- ABC Edition Zurich., Gem Testing 10th Ed.
9. B.W. Anderson (1990) Butterworth Scientific London., Gemstone Enhancement 2nd Edition,
10. Nassan K. (1994) Butterworths London., Gems 5th Ed. Webster Butter worths London., Hall, C. Gemstones. ISBN 1564584992.
11. Dorling Kindersley, (1994)., Read, P. Gemmology. ISBN 0750644117.
12. Butterworth Heinemann, (1999)., O' Donoghue, M. Identification of Gemstones. ISBN 0750655127.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	1	2	3	3	2	2	2	3	2	1
CO 2	3	1	1	2	3	3	2	2	2	3	2	1
CO 3	3	2	1	2	3	3	2	2	2	3	2	1
CO 4	3	3	1	2	3	3	2	2	2	3	2	1
CO 5	3	2	1	2	3	3	2	2	2	3	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

22UPGS04 - RAINWATER HARVESTING AND ARTIFICIAL GROUNDWATER RECHARGE

Course Objectives

- To understand the importance of rainwater harvesting for water supply and will learn about different types of rainwater harvesting systems.
- To get familiar with different potential uses of rainwater and understand the advantages and limitations.
- To get familiar with different components of Groundwater management strategy.
- To make them understand about the Artificial groundwater recharge structures.
- To understand and explain the main quality concerns with respect to BIS and WHO standards.

Course Outcomes

- Understands different potential uses of rainwater advantages and limitations.
- Students get a exposure of different components of Groundwater management strategy
- Learned about the potential of rainwater harvesting under different circumstances
- To have preliminary ideas pertaining to watershed development and management strategies.
- Enhance the distribution and movements of groundwater resources on global scenario.

Unit I

Hydrological cycle and its components. Surface water and groundwater. Vertical distribution of groundwater. Over-exploitation of groundwater - Need for artificial recharge and rainwater harvesting - types of wells - drilling technology - design, construction and development of water wells: dug, bore and tube wells.

Unit II

Types of pumps - various artificial recharge structures: recharge ponds - recharge pits - percolation ponds - basin spreading - surface and subsurface dykes - recharge wells - recharge bore wells. Rainwater harvesting in urban areas : RWH structures - design - construction.

Unit III

Estimation of probable runoff from an area including from rooftops - maintenance and monitoring of RWH structures - benefits - effects on local groundwater environments - remedial measures. Recycling of domestic water - sources of water to recharge in urban areas. Aquifer and its types.

Unit IV

Water table and its fluctuations. Water quality parameters. BIS and WHO standards. watershed management strategy. Salt water intrusion and remedial measures. Interlinking of rivers in India. Indian monsoon pattern. Role of meteorological department. Integrated Water Resources Management (IWRM) Approach: IWRM Principles: Modern principles for water management and planning, definition, components, and critique of IWRM.

Unit V

Groundwater management strategy, recycling of effluent water, sources of water contamination and remedial measures. Impact of urbanization on water resources. Definition for river basin, sub basin, watershed and micro watershed. Role of public in watershed management practices at village level. Sustainable Water Resources Management: Concept of sustainable development, sustainability principles for water management, goals for guiding sustainable water resource management.

Text / Reference Books

1. Rajora,R.,(1998), Integrated Watershed Management, Rewat Publications, New Delhi.
2. Lal.S., (2004), Watershed, Development, Management and Technology, Mangal Deep Publications,358p.
3. Paranjape,S.et.al.,(1998), Watershed Based Development: A Source Book, Bharat Gyan Vigyan Samathi, New Delhi.
4. Suresh.R.,(2002), Soil and Water Conservation Engineering, Standard Publishers and Distributers, Delhi.
5. Kakade,B.K.,(2002), Soil and Water Conservation Structures in Watershed Development Programmes ,BAIF Development Research Foundation, Pune.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	1	3	2	3	2	1	3	2	1	1
CO 2	3	1	2	3	2	3	1	1	2	2	2	1
CO 3	3	2	1	3	2	3	1	3	3	1	1	1
CO 4	3	2	1	3	2	3	2	2	3	2	1	1
CO 5	3	2	1	3	2	3	2	2	2	2	1	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying

22UPGS05-GEOHAZARDS

Course Objectives

- To explain students about the physical and geological processes causing geohazards.
- To discuss the methods for quantifying geohazards.
- To understand the possible consequences as well as risk and disaster management.
- To make them aware about landslides, floods, tsunamis and earthquakes, for which the geological and physical process were to be discussed.
- To discuss potential interlinkages between different types of geohazards, disaster prevention and management and quantification and communication of uncertainties.

Course Outcomes

- Explain the physical and geological processes causing geohazards such as landslides, floods, tsunamis and earthquakes.
- Describe methods for quantifying hazard for the individual geohazards and factors controlling their uncertainty.
- Explain possible consequences of geohazards as well as risk and disaster management.
- Complete a basic hazard assessment for selected geohazards.
- Gain an additional knowledge on possible interactions between geohazards and their consequences.

Unit I

Natural Hazard – definition -Earth's processes: catastrophic geological hazards: study of floods, tsunamis, Landslides, Earthquakes, Volcanism and avalanches – with a view to assess the magnitude of the problem, prediction and perception of the hazards. Laws and regulations towards hazard management.

Unit II

Earthquakes-Definition –focus -epicenter-seismic waves-intensity and magnitude- Richter scales – Tsunami -Seismograph- seismogram-seismicity in Indian region - Seismic gaps - mitigation measures and management. Preparation of seismic hazard map.-Seismic Gap.

Unit III

Volcanoes-Definition-structure - types –Global distribution - mitigation measures and management. Avalanche – Definition – types – mitigation. Flood- Definition - causes -

vulnerable zones in India-Mitigation measures and management. Monitoring and prediction of eruptions: short term, long term. Coastal erosion – its causes-mitigation measures and management.

Unit IV

Landslides- types -slow flowage, rapid flowage, sliding and subsidence – causes and mechanism - Vulnerable zones in India - mitigation measures and management. Deforestation and land degradation-Cyclone- Definition -causes - vulnerable zones in India-mitigation measures and management. Weather, temperature and pressure differences, trade and westerly winds, adiabatic cooling, cold and warm fronts.

Unit V

Mass movement – factor influencing slope stability – types of mass movement – hazards of mass movement – strategies for their reduction and the role of geology. Soil erosion – Soil formation – soil classification – factor influencing soil erosion – hazards of soil erosion – Drought – types, mitigation measures. Waves, beaches, coastal erosion: wave characteristics, summer and winter beaches, wave refraction and longshore drift; sand supply and cliff erosion.

Text / Reference Books

1. Geology, environment, Society K.S.Valdiya (2004) Universities Press (India) Private Limited, Hyderabad,India
2. Coping with natural hazards: Indian context K.S.Valdiya (2004) Orient Longman Private Limited, Hyderabad,India.
3. Engineering and General Geology, Parbin Singh (2003) S.K.Kataria and sons Delhi India
4. General Geology V.Radhakrishnan (1996) V.V.P.Publishers, Tuticorin,India.
5. Lundgren (1986). Environment Geology, Prentice Hall Publishers, New Jersey.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	1	1	2	3	3	2	1	2	2	2	1
CO 2	3	1	1	2	3	3	2	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	3	1	1
CO 4	3	2	1	2	3	3	2	1	2	2	2	1
CO 5	2	2	1	2	3	3	2	2	2	2	1	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying.

22UPAGFT - GEOLOGICAL MAPPING AND FIELD TRAINING

Course Objectives

- The creation, analysis and interpretation of geological maps are important skills in geology.
- Geological maps present the distribution of lithologic units and geological structures and their geometric relationships in a given area.
- To learn geological mapping techniques in an area of broad lithological and structural diversity.
- To create a geological map and to interpret and discuss the results in a regional tectonic context.

Course Outcomes

- To provide a comprehensive training on field geology.
- The students will learn and develop skills in interpreting geological features at different scales and finally analyze them in four-dimensions to propose the history and evolution of the studied region, in general.
- The course will employ their fundamental understanding on the principals of Stratigraphy, Sedimentology, Structural Geology and Petrology.

Course Content

Introduction and general geological overview of the region; Identification of the litho-units and their boundaries with the adjacent rocks; Structural and petrological disposition; identification and construction of stratigraphic succession; Recognition of syn-sedimentary and post-lithified deformation; Techniques of Geological mapping with special attributes to rock-type, structural elements and metamorphic-grade; Presentation of the field data.

Skills

- can accurately locate in the field, using topographic maps, pacing and compass are familiar with standard map symbols and map elements including scale and legend
- can take and document structural field data and field observations
- can apply outcrop mapping techniques and create a geological map
- can construct geological cross-sections and can develop a geological history thereof

Text / Reference Books

1. Badgely, P.C. (1959) Structural Methods for the Exploration Geologist. NewYork, Harper Bros

2. Barnes, J.W. (2000) Geological maps and map-making. In The Oxford Com- panion to the Earth. Oxford, OUP, 408–410

3. Compton, R.R. (1966) Manual of Field Geology. 2nd edn, New York, Wiley

4. Forrester, J.D. (1964) Principles of Field and Mining Geology. New York,Wiley

5. Lisle, R.J. (2003) Geological Structures and Maps. 3rd edn, London, Butter-worth-Heinemann

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	3	3	1	2	3	2	2	1
CO 2	3	3	2	2	3	3	3	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	1	1	1
CO 4	3	3	2	2	3	3	2	2	2	1	2	2
CO 5	3	2	2	1	3	3	2	2	3	2	2	1

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding, K3- Applying.

22UPAGIT – INTERNSHIP TRAINING

Course Objectives

- All geology majors are encouraged to seek out and experience a work internship.
- Apply employment skills in resume writing, job portfolio preparation, networking and interviewing.
- Find employment in an area that the student would like to work in, to gain actual hands-on experience.

Course Outcomes

- Gain a greater vision of what it means to be employed in the particular field a student chooses to work in upon graduation.
- Establish professional career networking likes that will assist the student in gaining employment upon graduation.
- Apply and expand the principles and skills learned in the classroom to real-world problems/projects.

Text / Reference Books

1. Sgroi, C.A., & Ryniker, M. (2002). Preparing for the real world: A prelude to a fieldworkexperience. Journal of Criminal Justice Education, 13(1), 187 - 200.
2. Baird, B.N. (2002). The internship, practicum and field placement handbook: A guidefor the helping professions (3rd Ed.). Upper Saddle River, NJ: Prentice Hall.
3. Williams, J.K.M. (1975). The practice seminar in social work education. In J.K.M.Williams (Ed.), The dynamics of field instruction (pp. 94-101). New York: Council forSocial Work Education.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	3	3	1	2	3	2	2	1
CO 2	3	3	2	2	3	3	3	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	1	1	1
CO 4	3	3	2	2	3	3	2	2	2	1	2	2
CO 5	3	2	2	1	3	3	2	2	3	2	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying.

22UPAGPJ - PROJECT WORK / DISSERTATION

Course Objectives

- Each Student will undergo a project/Internship training programme in a reputed Geological organizations for two to three weeks
- Students will individually select a topic / supervisor/ guide in the faculty of the Department and submit a project for Evaluation.
- To train the students in preparing project reports and to face the final viva-voce examination.

Course Outcomes

- Students will get hands on training in the reputed organization related to the project work.
- Student will get trained in a specific field of specialization.
- Students will have the practice of writing a project report.
- On completion of the project work, Students will be in a position to take up any challenging practical problem and find out better solution for our National growth.

During the IV Semester, the students shall undertake a Dissertation on a topic of Geology. The topic of Dissertation shall be assigned to the students in the beginning of the Third Semester. Based on the overall merit of the student during previous two Semesters and Faculty available in the Department, they would be allotted a project and attached to a Faculty Member in the Department who would act as their Dissertation Supervisor. The students shall remain in contact with their Supervisor, for day-to-day progress of the work done by them. During the course of completion of the Dissertation work, the student will be required to complete various assignments given to them by their respective Supervisor, for the purpose of evaluation.

The students will be required to submit the Dissertation by the date specified to them in the Fourth Semester. This will be followed by a Presentation before panel of Examiner(s) for the purpose of evaluation. The Dissertation shall be of 200 Marks out of which 100 Marks will be evaluated by supervisor on the basis of submitted Dissertation Work (Thesis), 50 Marks for the Multimedia Presentation followed by 50 Marks for Viva-voce Examination evaluated by panel of examiners.

Text / Reference Books

1. British standards institution, British standard 1629, Bibliogrpahical references, London, 1950
2. Hart, Horace, rules for compositors and readers at the University press Oxford, 37th edition, London, 1967.
3. Madge, John, the tools of social science, London, 1953
4. Turabian, Kate L., A Manual for Writers of Term Papers, Theses and Dissertations, 3rd edition, Chicago, 1967.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	3	3	1	2	3	2	2	1
CO 2	3	3	2	2	3	3	3	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	1	1	1
CO 4	3	3	2	2	3	3	2	2	2	1	2	2
CO 5	3	2	2	1	3	3	2	2	3	2	2	1

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding, K3- Applying.

VALUE ADDED COURSES
(CERTIFICATE COURSE – EXTRA CREDITS)

22UPAGVA01-HYDROLOGY AND WATER MANAGEMENT

Course Objectives

- To learn the fundamental components of hydrological cycle and distribution of fresh and salt water of the Earth.
- To impart theoretical, practical and field knowledge pertaining to Hydrogeological domain.
- To understand the physical, chemical and biological characteristics of water with special emphasis on pollution and contamination.
- To understand the relationship in between water and rock interaction and salt water intrusion and its remedial measures in the coastal aquifers.
- An ability to ethical, social, health and sustainable consumption of water resources.

Course Outcomes

- Capable of understanding the impact of water conservation methods in regional and national context.
- An ability to understand the importance of groundwater augmentation strategies.
- To perform socio economic analysis to evaluate the intangible benefits of artificial structures.
- Formulate and solve deterministic and optimization models for water resources.
- To get familiarization of principles and applications of various groundwater exploration techniques.

Unit-I

Introduction to Groundwater, Hydro meteorology, Groundwater in Hydrologic Cycle, Occurrence of groundwater, zone of Aeration and Saturation, Hydrogeology, Types of aquifers soil sample analysis - Water bearing materials, Aquifer parameters and its determination. Evaporation and its measurement- Evapotranspiration and its measurement-Penman Monteith method-Infiltration- Factors affection infiltration-Hyetograph-Runoff-drainage basin characteristics- Hydrograph concepts assumptions and limitations of unit hydrograph.

Unit-II

Occurrence and movement of groundwater- Darcy's law-governing ground water flow equations-Factors governing ground water flow- Types of aquifers- porosity- specific yield specificretention - storage coefficient-permeability- hydraulic conductivity- hydraulic transmissibility-Conjunctive use and it's necessity. Types of Investigations- Site selection-Zones of storage - Safe yield- Reservoir capacity- Reservoir sedimentation and control.

Unit-III

Indian rivers and floods- Causes of flooding- Alleviation- Leeves and flood walls Floodways-Channel improvement- Flood damage analysis-Design flood- Flood estimation-Frequency analysis- Flood routing through reservoirs and open channels- Storm drainage design.

Unit-IV

Definition of drought- Causes of drought- measures for water conservation an augmentation-drought contingency planning-Water harvesting: rainwater collection-small dams-runoff enhancement- runoff collection- ponds- tanks- natural and artificial ground water recharge methods

Unit V

Introduction - Components of Hydroelectric Power Plant-Levels in planning-Functional requirements of water resources projects-steps in water resources planning- Environmental aspects in water resources planning

Text / Reference Books

1. Garg S.K., Hydrology and Water Resources Engineering
2. Subramanya, K., Engineering Hydrology, Tata McGraw Hill, New Delhi.
3. Raghunath, H.M., Groundwater, 1987, Wiley Eastern Ltd., New Delhi.
4. Modi, P.N., Irrigation Water Resources and Water Power Engineering, Standard Book House, New Delhi.
5. Todd, D.K., Groundwater Hydrology, 1993 John Wiley & Sons..
6. Raghunath, H.M., Hydrology – Principles, Analysis and Design, 1986, Wiley
7. Dr. P.Jaya Rami Reddy, A Textbook of Hydrology, University Science Press.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	3	3	1	2	3	2	2	1
CO 2	3	3	2	2	3	3	3	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	1	1	1
CO 4	3	3	2	2	3	3	2	2	2	1	2	2
CO 5	3	2	2	1	3	3	2	2	3	2	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying.

22UPAGVA02 - ENVIRONMENTAL STUDIES AND EARTH SCIENCES

Course Objectives

- To learn the fundamental components of hydrological cycle and distribution of fresh and salt water of the Earth.
- To impart theoretical, practical and field knowledge pertaining to Hydrogeological domain.
- To understand the physical, chemical and biological characteristics of water with special emphasis on pollution and contamination.
- To understand the relationship in between water and rock interaction and salt water intrusion and its remedial measures in the coastal aquifers.
- An ability to ethical, social, health and sustainable consumption of water resources.

Course Outcomes

- Capable of understanding the impact of water conservation methods in regional and national context.
- An ability to understand the importance of groundwater augmentation strategies.
- To perform socio economic analysis to evaluate the intangible benefits of artificial structures.
- Formulate and solve deterministic and optimization models for water resources.
- To get familiarization of principles and applications of various groundwater exploration techniques.

Unit-I

Renewable and non-renewable resources: Natural resources and associated problems-Forest resources: deforestation- Timber extraction, mining, dams and their effects on forest -Water resources - Use and over-utilization of surface and groundwater-floods- Energy resources - Growing energy needs-renewable and nonrenewable-energy sources- use of alternate energy sources- man induced landslides- desertification- Human Settlements and their impact on Environment.

Unit-II

Structure and function of an ecosystem- Principles of Ecology: Composition and various Types of Ecosystem - Ecological succession-Food chains-food webs and ecological pyramids- Introduction-types- characteristic features- structure and function of the Forest ecosystem-Grassland ecosystem-Desert ecosystem-Aquatic ecosystems

Unit-III

Definition-Cause effects and control measures of Air pollution-Water pollution-Soil pollution-Marine pollution-Noise pollution-Thermal pollution-Nuclear hazards-Solid waste Management – Causes- effects and control measures of urban and Industrial wastes-Disaster Management -floods- earthquake- cyclone and landslides. National and Global Environmental Issues. Environmental Impact Assessment (EIA), general guidelines for the

preparation of environmental impact statement (EIS), scope and types of environmental audit, cost benefit analysis, environmental management plan (EMP), international organization for standardization (ISO).

Unit-IV

Mechanical layering of the Earth-lithosphere- asthenosphere- mantle and core-Earthquake and earthquake belts: seismic waves and internal constitution of the Earth-Volcanoes and volcanism-distribution of volcanoes-Concept of Isostasy, Formation of core-mantle- crust-atmosphere-hydrosphere and biosphere-Convection in Earth's core.

Unit V

Origin and Age of the Earth, Historical development of the concept of continental drift and plate tectonics-Plates and plate boundaries-Geodynamic elements of Earth- mid oceanic ridges- trenches- transform faults and island arcs-Plate tectonics- mountain belts and rift valleys.

Text / Reference Books

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner. Bharucha Erach, The Biodiversity of India, Map in Publishing Pvt. Ltd., Ahmedabad – 380 013, India.
2. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p Clark R.S., Marine Pollution, Clanderson Press Oxford (TB).
3. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p
4. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p
5. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
6. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment Cambridge Univ. Press 1140p.
7. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
8. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
9. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p 10. Duff, P. M. D. and Duff, D. (Eds.) (1993). Holmes' principles of physical geology. Taylor and Francis.
10. Emiliani, C. (1992). Planet Earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.
11. Gross, M. G. (1977). Oceanography: A view of the earth.
12. Tarback, E. J. and Lutgens, F.K. (2006). Earth Science. Pearson Prentice Hall, New Jersey.
13. Grotzinger, J., Jordan, T.H., Press, F and Siever, R. (2007) Understanding Earth (Fifth Edition). W. H. Freeman and company, New York.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	3	3	1	2	3	2	2	1
CO 2	3	3	2	2	3	3	3	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	1	1	1
CO 4	3	3	2	2	3	3	2	2	2	1	2	2
CO 5	3	2	2	1	3	3	2	2	3	2	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying.

ADD ON COURSES

22UPAGAO01-MEDICAL GEOLOGY

Course Objectives

- The geochemistry of the environments has a marked influence on their health, giving rise to diseases that affect millions of people.
- To expose the students on the interaction of Human beings with the geochemistry of the earth environment.
- To learn the fundamental components of Medical Geology.

Course Outcomes

- Capable of understanding the impact of health due to water borne diseases.
- An ability to understand the importance of Pathways and Exposure.
- To perform socio economic analysis to evaluate the intangible benefits of artificial structures.
- The study of the Agricultural, Soil and Crops on the Nutritional Health of Humans.
- To get familiarization of principles and applications of Microprobe Analysis in Medical Geology.

Unit-I

General characteristics of tropical, subtropical environments, arid zone, seasonally dry tropics and sub-tropics, humid tropics, and sub-tropics zone and mountainous zone. Rock weathering and soil formation, weathering of mineralized terrains, weathering profiles. Weathering and formation of secondary minerals. Chemistry of weathering of ultra-basic rocks.

Unit-II

Medical Geology- Perspectives and Prospects, Public Health and Geological Processes: An Overview of a Fundamental Relationship. Environmental Biology-Natural Distribution and Abundance of Elements, Anthropogenic Sources, Uptake of Elements on Chemical and Biological Perspective and its functions, Geological Impacts on Nutrition.

Unit-III

Pathways and Exposure- Volcanic Emissions and Health, Radon in Air and Water, Arsenic in Groundwater and the Environment. WHO and BIS Standards for drinking water. Fluoride

in Natural Waters, soils, sediments, plants. Fluorides and health: Bioavailability of fluoride, Dental fluorosis, Skeletal fluorosis, Dental fluorosis in India, source, nature, cause and extent. Water Hardness and Health Effects, Geochemical basis for tropical endomyocardial fibrosis (EMF), Effect of water hardness on urinary stone formation. Types of stones: Calcium oxalate, Calcium phosphate, Uric acid, Magnesium ammonium phosphate stones, Cysteine

Unit-IV

Iodine and health: The iodine cycle in the environment, Iodine in drinking water, Iodine in food, Iodine Deficiency Disorders (IDD), Endemic cretinism, Goitrogens. The nitrogen cycle, Nitrate as fertilizers and environment, Nitrogen loading in rice fields, Nitrates from human and animal wastes, Nitrates and health, Nitrates and Methemoglobinemia, Nitrates and cancer. Bioavailability of Elements in Soil, Selenium Deficiency and Toxicity in the Environment, Soils and Iodine Deficiency, Natural Aerosolic Mineral Dusts and Human Health, Animals and Medical Geology. The Impact of Micronutrient Deficiencies in Agricultural Soils and Crops on the Nutritional Health of Humans.

Unit V

Environmental Toxicology, Environmental Epidemiology, Environmental Medicine, Environmental Pathology, Speciation of Trace Elements. Techniques and Tools GIS in Human Health Studies, Investigating Vector-Borne and Zoonotic Diseases with Remote Sensing and GIS. Mineralogy of Bones, Inorganic and Organic Geochemistry Techniques, Histochemical and Microprobe Analysis in Medical Geology.

Text / Reference Books

1. C.B. Dissanayake and R.Chandrajith (2009). Introduction to Medical Geology, Springer, London
2. H.Catherine, W.Skinner, Antony R. Berger(2003). Geology and Health: Closing gap, Oxford Univ. press, New York.
3. Iosif F.Volfson (2010). Medical Geology: Current Status and Perspectives, 2010. Russian Geological Society (ROSGEO) Publisher. Moscow.
4. K.S. Valdiya (2004). Geology, environment, Society, University press (India), Hyderabad.
5. Lawrence K. Wang, Jiaping Paul Chen, Yung-Tse Hung, Nazih K. Shammas (2009). Heavy Metals in the Environment , CRS Press, Taylor & Francis Group, Boca Raton, FL
6. M.M. Komatica, (2004) Medical Geology, Vol.2, Effects of geological environment on Human health , Elsevier, U.K.
7. Oile Selinus, B. Elsevier(2003). Essentials of Medical Geology (2005), Acemedica Press.,U.K.
8. Oile Selinus, B. Finkleman, R.B., A.Jose (2010) Medical Geology- Regional synthesis(2010), Springer, London.
9. Scott S. Olson, (1999) International Environmental Standards Handbook , CRC Press, London.CKE
10. William N.Rom, (2012). Environmental Policy and Public Health - Air Pollution, GlobalClimate Change, and Wilderness, by John Wiley & Sons, Inc. Published by

JosseyBass A Wiley Imprint.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	3	3	1	2	3	2	2	1
CO 2	3	3	2	2	3	3	3	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	1	1	1
CO 4	3	3	2	2	3	3	2	2	2	1	2	2
CO 5	3	2	2	1	3	3	2	2	3	2	2	1

Note: POs-Program Outcomes , PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding , K3- Applying.

22UPAGAO02-PETROLEUM GEOLOGY

Course Objectives

- To solving technical challenges connected to the development and production of hydrocarbon reservoirs on a regional to reservoir scale.
- Petroleum is one of the most important resources of energy therefore the basic understanding of petroleum is important.
- To understand the concept of petroleum system.
- To understand the Geographic and Stratigraphic distributions of oil and gas.
- An ability to infer the Petroleum economics, production and development.

Course Outcomes

- Capable of understanding the Renewable and Non-Renewable Energy.
- An ability to understand the importance of hydrocarbon potential generation of Petroleum.
- To perform Petroleum source rock origins, Hydrocarbon Traps.
- Formulate and solve deterministic and optimization models of Petroleum Resources Sedimentary Basins.
- To get familiarization of principles and applications of estimation of reserves and resources.

Unit-I

Physical and Chemical Properties of Petroleum Origin and composition of petroleum and natural gas, source rocks, reservoir rocks and traps. Migration and accumulation of oil and gas. Introduction to Petroleum Geology, History of Petroleum, Energy Resources, Renewable Energy, Non-Renewable Energy, fossil Fuels.

Unit-II

Concept of petroleum system. Reservoir rocks clastic and non-clastic reservoir rocks, development and types of porosity in these rocks. Controls of permeability. Types of petroliferous basins and their relation to hydrocarbon potential Generation of Petroleum, Migration of Petroleum: primary and secondary; Reservoir Characteristics: Porosity and permeability.

Unit-III

Geographic and stratigraphic distributions of oil and gas. Methods and techniques for

petroleum exploration, Surface indications and direct detection of hydrocarbons Subsurface Environments. Source Rock Origins, Hydrocarbon Traps: Structural Traps, Stratigraphic traps, hydrodynamic traps; Combination traps, Oil Exploration, Application of microfossils in petroleum.

Unit-IV

Sub-surface geological methods and brief idea about geologic interpretations of seismic data. Drilling methods, drilling equipments, drilling fluids, well-logs. Exploration Methods Reservoirs, Traps and Seals Nonconventional Petroleum Resources Sedimentary Basins and Petroleum Systems Well logging: SP log, Gamma Log, Sonic log, gas drive, gas cap drive, gas hydrate.

Unit V

Estimation of reserves and resources. Petroleum economics, production and development geology. Petroleum traps. Cap rocks (seals). Occurrence, surface indications and direct detection of hydrocarbons. Petroleum habitats. An outline of the oil belts of the world Oil producing basins of India: Assam, Krishna-Godavari, Bombay, Cambay, and Rajasthan.

Text / Reference Books

1. Tissot, B.P. and Welte, D.H. Petroleum Formation and Occurrence, 2nd Edition, Springer- Verlag, Berlin, 1984
2. North, F.K. Petroleum Geology, Allen & Unwin, London, 1985
3. Hunt, J.M. Petroleum Geochemistry and Geology, 2nd Edition, W.H. Freeman, San Fransisco, 1996
4. Sahay, B., Rai, A. and Ghosh, M. Wellsite Geological Techniques for Petroleum Exploration, Oxford & IBH, New Delhi, 1984
5. Selley, R.C. Elements of Petroleum Geology, 2nd Edition, Academic Press, London, 1997
6. North, F. K. 1985, Petroleum geology Petroleum Geology. Published by Kluwer Academic Publishers. Levorsen, I., 2001, Geology of Petroleum AAPG special publication. American Association of Petroleum Geologists Chapman, R.E.,2004, Petroleum Geology, Elsevier
7. Barker, C. (1996): Thermal Modeling of Petroleum Generation, Elsevier Science.
8. Holson, G.D. and Tiratso, E.N. (1985): Introduction of Petroleum Geology, Fulf Publ. Houston.
9. Hunt, J.M. (1996): Petroleum geochemistry and geology (2nd Ed.), Freeman, San Francisco.
10. John, F., Cook, M. and Graham, M.(1998):Hydrocarbon Exploration and Production, Elsevier Science.
11. Makhous, M. (2000): The Formation of Hydrocarbon Deposits in North African Basins, Geological and Geochemical Conditions, Springer–Verlag.
12. North, F.K. (1985): Petroleum Geology, Allen Unwin.
13. Selley, R.C. (1998): Elements of petroleum geology, Academic Press.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	3	3	1	2	3	2	2	1
CO 2	3	3	2	2	3	3	3	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	1	1	1
CO 4	3	3	2	2	3	3	2	2	2	1	2	2
CO 5	3	2	2	1	3	3	2	2	3	2	2	1

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22UPAGAO03 - GROUNDWATER EXPLORATION

Course Objectives

- To learn the fundamental components of hydrology and basin characteristics.
- To impart theoretical, practical and field knowledge pertaining to Hydrogeological domain.
- To understand the subsurface methods of groundwater exploration.

Course Outcomes

- Capable of understanding the impact of water conservation methods.
- An ability to understand the importance of groundwater augmentation strategies.
- To get familiarization of principles and applications of various groundwater exploration techniques.

Unit-I

Renewable resource Renewable resource, Hydrology and basin characteristics, run-off and stream flow, aquifer characteristics, geology of groundwater occurrence, trans-boundary aquifers, groundwater quality, saline water intrusion.

Unit-II

Esoteric method: Water divining, Soil and Micro-Biological Methods Biophysical.

Unit-III

Surface investigation: Geologic method, geomorphological method, hydrogeological method, electrical resistivity method, Vertical electrical sounding. Profiling, Wenner array, Schlumberger array, Dipole-dipole array, Interpretation of data, electromagnetic method, seismic method, gravity and magnetic method, geobotanical methods, geochemical methods

Unit-IV

Subsurface methods: test drilling, water level measurements. Application of Geophysical logging in Groundwater exploration, tracer techniques.

Unit V

Aerial method, Photogeology, Landsat / IRS Infrared imagery, Electromagnetic techniques. Remote sensing methods, artificial recharge, groundwater modeling, groundwater law, watershed management.

Text / Reference Books

1. Davies, S.N. and De Wiest, D.R., (1966), Hydrogeology-John Wiley& sons, Inc, New York, 463p.
2. Fetter, C.W., (1990), Applied Hydrogeology-Mc Graw Hill, Publisher, New Delhi.
3. Handa.O.P (1984), Groundwater Drilling, Oxford & I.B.H. Publishing Co.
4. Hiscock,K.,(2005), Hydrogeology, Principles and Practice, Blackwell Publishing,389p.
5. Karanth, K.R., (1987), Groundwater Assessment, Development and Management-Tata McGraw Hill New Delhi 720p.
6. Raghunath, H.M., (2007), Groundwater 3rd edition, New Age International Publishers,520p.
7. Schwartz, F.W and Zhang, H.,(2003), Fundamentals of groundwater, John Wiley& sons, Inc, New York,583p.
8. Shaw,E.M., (1994), Hydrology in Practice,3rd edition, Chapman and Hall,London,569p.
9. Subramaniam, V., (2000), Water-Kingston Publ. London.
10. Todd, D.K., (1980), Groundwater Hydrology-John Wiley & Sons Publishers, New York, 535p.
11. Venkateswaran.S (2010) Groundwater exploration techniques, TNBH publishers, Chennai, Tamil Nadu. ISBN 978-81-9234-992-3.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	3	3	3	1	2	3	2	2	1
CO 2	3	3	2	2	3	3	3	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	1	1	1
CO 4	3	3	2	2	3	3	2	2	2	1	2	2
CO 5	3	2	2	1	3	3	2	2	3	2	2	1

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective & Cognitive level: K1- Remembering, K2- Understanding, K3- Applying.