PERIYAR UNIVERSITY

NAAC 'A' Grade – State University

SALEM – 636 011, TAMIL NADU

DEPARTMENT OF GEOLOGY

DST-FIST Sponsored Department

M.Sc., Applied Geology

Choice Based Credit System - CBCS

OBE – SYLLABUS

Effective from the Academic year 2018-2019 onwards and thereafter

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

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.

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.

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.

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.

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.

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.

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.

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.

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.

Massive Open Online Course (MOOC)

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.

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.

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.

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.

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.

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.

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.

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.

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

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.

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

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	18AGC01	Applied Geomorphology	4	25	75	100	4
2	18AGC02	Structural Geology and Geotectonic	4	25	75	100	4
3	18AGC03	Mineralogy	4	25	75	100	4
4	18AGC04	Palaeontology	4	25	75	100	4
5	18AGE…	Elective I/II	4	25	75	100	4
6	18AGP01	Practical –I Structural Geology, Mineralogy and Palaeontology*	4	40	60	100	4
7	18AGM01	MOOC Course – I	-				4
II-Semester							
1	18AGC05	Igneous and Metamorphic Petrology	4	25	75	100	4
2	18AGC06	Sedimentology	4	25	75	100	4
3	18AGC07	Stratigraphic Principles and Indian Stratigraphy	4	25	75	100	4
4	18AGC08	Exploration Geology	4	25	75	100	4
5	18AGP02	Practical – II Petrology and Sedimentology*	4	40	60	100	4
6	18AGE…	Elective – III / IV	4	25	75	100	4
7	---	Supportive Course	3	25	75	100	3
8		Human Rights -Duties	-				
9	18AGM02	MOOC Course – II	-				4
10	18AGFT	Geological Mapping/ Field Training	-				
III-Semester							
1	18AGC09	Economic Geology	4	25	75	100	4
2	18AGC010	Applied Micropalaeontology	4	25	75	100	4
3	18AGC011	Applied Hydrogeology	4	25	75	100	4
4	18AGC012	Advanced Remote Sensing and GIS	4	25	75	100	4
5	18AGP03	Practical – III Economic Geology and Micropaleontology*	4	40	60	100	4
6	18AGP04	Practical – IV Hydrogeology, Remote Sensing and GIS*	4	40	60	100	4
7	18AGIT	Internship Training	-				
IV- Semester							
1	18AGC013	Fuel Geology	4	25	75	100	4
2	18AGE…	Elective V/VI	4	25	75	100	4
3	18AGPJ	Project/Dissertation	7	50	150	200	7
Elective Courses							
1.	18AGE01	Mining and Engineering Geology	4	25	75	100	4
2.	18AGE02	Analytical and Instrumentation Techniques	4	25	75	100	4
3.	18AGE03	Applied Stratigraphy	4	25	75	100	4
4.	18AGE04	Meteorology and Climate Change	4	25	75	100	4
5.	18AGE05	Environmental Geology	4	25	75	100	4
6.	18AGE06	Marine Geology	4	25	75	100	4
Supportive Courses							
1.	18GS01	Earth System Science	3	25	75	100	3
2.	18GS02	Water Resources Management	3	25	75	100	3
3.	18GS03	Gemmology	3	25	75	100	3
4.	18GS04	Rainwater Harvesting and Artificial Groundwater Recharge	3	25	75	100	3
5.	18GS05	Geohazards	3	25	75	100	3
Massive Open Online Course (MOOC)							
1	18AGM01	Mineral Resources: Geology, Exploration, Economics and Environment	-				4
2	18AGM02	Introduction to Geographic Information System	-				4
3	18AGM03	Disaster Management	-				4
4	18AGM04	Introduction to Mineral Processing	-				4
5	18AGM05	Geology and Soil Mechanics	-				4

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

Credits for Core Courses	75	Credits for MOOC Courses	08
Credits for Elective Courses	12	Credits for Human Rights-Duties	02
Credits for Supportive Courses	03		
Total Credits	90		

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)

Syllabus for M.Sc., Applied Geology

18AGC01 – 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. Evolution of geomorphic concepts. Principles/laws of geomorphology. Endogenic and exogenic driving forces. Resisting forces. Dynamic equilibrium of driving and resisting forces and Threshold. Modern concepts, quantitative geomorphology, process geomorphology.

Unit II

Role of tectonics, climate, slope, lithology, vegetation, land cover/land use and human in landscape evolution. Spatio-temporal scale of geomorphic processes. Mineral stability series. Physical, chemical and biological weathering. Soil profiles, Types of soils. Erosional and Depositional landforms. Agents of geomorphic processes – Volcanism, Gravity, glaciers, wind, rivers, tides, waves, currents.

Unit III

Classification of mountains, Types of volcanoes. Volcanic landforms. Isostasy, Tectonic landforms, Gravity landforms. Climate zones of the World. 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

Overland and subsurface flow. Fluvial process. Types of drainage pattern. Fluvial landforms. Types of Deltas. Classification of coast lines, Depositional and erosional coast lines. Coastal and marine landforms.

Unit V

Geomorphic sub-divisions of Indian sub-continent – 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.

Text / Reference Books

1. Bloom.A.L. (1992), Surface of the Earth, Prentice Hall India, New Delhi
2. Gass, I.G., Smith, P.S & Wilson, R.C.L., 2ndEdt., (1972), Understanding the Earth, The English Language Books Society, London
3. Holmes.A, (1972), Principles of Physical Geology The English Language Book Society and Nelson
4. Jacob.J, Russel, R.D & Wilson, J.T, (1959), Physics and Geology, McGraw – Hill, New York.
5. Leopold,L.S, Wolman, K & Miller, J.P, (1970), Fluvial processes in Geomorphology, Eurasia Publishing House Pvt Ltd., New Delhi.
6. Richard Huggett (2007) Fundamentals of Geomorphology. II Edition.
7. Robert, S.A. and Suzanne, P.A.,(2010) Geomorphology – The mechanics and chemistry of landscapes. Cambridge University Press.
8. Routledge N. Y. Ritter,D.F., Kochel, R.C.,Miller, J.R.,(2002) Process Geomorphology, Waveland press,.
9. Sagan, C. (1973). , Planetary Engineering on Mars, Icarus, 20, 513.
10. Sharma.H.S. (1990) Indian Geomorphology. Concept Pub. Co., New Delhi.
11. Thornbury, W.D., (2004) Principles of Geomorphology. II edition. Wiley Eastern Ltd. New Delhi.
12. Wyllie., P.J, (1971), Dynamic Earth, John Wiley & sons, New York.
13. 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.

18AGC02 - STRUCTURAL GEOLOGY AND GEOTECTONIC

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

Deformation, Stress and Strain

Deformation: Definition - Components of deformation. Strain: Homogeneous and heterogeneous deformation - One-dimensional strain, Strain in two dimensions, Three-dimensional strain - The strain ellipsoid. Uniaxial strain (compaction) - Pure shear and coaxial deformations - Simple shear - Progressive deformation and flow parameters - Steady-state deformation - Incremental deformation - Strain compatibility and boundary conditions. Stress: Definitions, magnitudes and units - Stress on a surface - Stress at a point - Stress components - The stress tensor (matrix) Deviatoric stress and mean stress Mohr circle and diagram. Rheology: Rheology and continuum mechanics - Idealized conditions - Elastic materials - Plasticity and flow: permanent deformation - The role of temperature, water, etc. Definition of plastic, ductile and brittle deformation.

Unit II

Brittle Deformation

Fracture : Brittle deformation mechanisms - Types of fractures - Failure and fracture criteria - Fracture termination and interaction - Fluid pressure, effective stress and pyroelasticity. Joints: Definition and characteristics - Kinematics and stress -How, why and where joints form - Joint distributions - Growth and morphology of joints - Joints, permeability and fluid flow.

Faults: Fault anatomy – Types of Faults – Recognition of Faults – Fault Geometry – Characteristics of Normal Faults – Shape and Displacement of Normal Faults – Kinematic Models of Normal Fault, Thrust or reverse faults, and strike-slip faults - Contractional faults - Thrust faults - Ramps, thrusts and folds - Extensional regimes: Extensional faults Fault systems Low-angle faults and core complexes - Ramp-flat-ramp geometries - Rifting Half-grabens and accommodation Strike-slip, transpression and transtension: Strike-slip faults - Transfer faults -Transcurrent faults - Development and anatomy of strike-slip faults – Transpression and transtension.

Unit III

Ductile Deformation

Folds and folding: Geometric parts of Folds – Kinematic of Flexural folding, Passive shear folding, Homogeneous flattening, Folding of multilayer - Formation of Kink and Chevron folds-Superposed folding. Folding: mechanisms and processes - Fold interference patterns and refolded folds - Fold in shear zones - Folding at shallow crustal depths.

Foliation and cleavage: Basic concepts - Types of foliation: Slaty cleavage or schistosity - Fracture cleavage- crenulations cleavage – Shear cleavage – Bedding cleavage – Axial plane cleavage. cleavage development- Cleavage, folds and strain.

Lineation: Types of Lineation: Intersection Lineation – Crenulation Lineation – Mineral Lineation – Stretched – pebble Lineation – Rodding Lineation – Mullion Lineation – Boudinage – Pencil Structures. Lineations related to plastic deformation Lineations in the brittle regime Lineations and kinematics.

Unit IV

Boudinage, Shear zones, and salt tectonites

Boudinage: Boudinage and pinch-and-swell structures - Geometry, viscosity and strain - Asymmetric boudinage and rotation - Foliation boudinage - Boudinage and the strain ellipse.

Shear zones and mylonites: Definition: shear zone - The ideal plastic shear zone Adding pure shear to a simple shear zone Non-plane strain shear zones Mylonites and kinematic indicators.

Salt tectonics Salt tectonics and halokinesis Salt properties and rheology Salt diapirism, salt geometry and the flow of salt Rising diapirs: processes Salt diapirism in the extensional regime Diapirism in the contractional regime Diapirism in strike-slip settings Salt collapse by karstification Salt décollements.

Unit V

Geotectonics

Plate tectonics: Concept of plate and plate movements, nature of convergent, divergent and conservative plate margins. Plate tectonics in relation to igneous, sedimentary and metamorphic processes and mineralization. Triple junctions, aulocogens, plume theory, island arcs. Nature and origin of earth's magnetic field. Evolution of Himalaya and Himalayan tectonics.

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. Paor, D. (1996). Structural Geology and Personal Computer, Pergamon,
12. Park, R.G., (1983). Foundations of Structural Geology, Blackie and Sons Ltd.
13. Ragan, D M John Wiley, (1985) Structural geology - An Introduction to Geometrical Techniques,
14. Ramsay.J.G&Huber.M.I, (1983), The Techniques of Modern Structural Geology: Vol I – Strain Analysis.

15. Ramsay.J.G&Huber.M.I, (1987), The Techniques of Modern Structural Geology: Vol II – Folds & Fractures

16. Rowland, S.M. and Duebendorfer, E.M. (1994).Structural Analysis and Synthesis, Pergamon,

17. Twiss, Robert J. and Moores, Eldridge M., (2007). Structural geology, W.H.Freeman and Company, New York., p.742

18. Uemura, T., and Mizutani, S., (1979). Geological Structures, Ed.Volume.John Wiley & Sons.

19. 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.

18AGC03 – MINERALOGY

Course objectives

- To understand the crystallography, its 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 crystal, space lattice and unit cell. Bonding in minerals. Nature of crystal. Symmetry elements. System of crystallization. Weiss and Millerian system of crystal notation. Interfacial angle. Twin crystals and Irregularities of crystals.

Unit II

X- rays study of crystal: Application of X- rays in the study of crystal structures. Classification and structure of silicates. Classification and structure of 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, uniaxial and biaxial minerals. Relative relief (RI) of minerals by Becke-line test. Extension angle and its types.

Unit IV

Crystal chemistry: Crystalline and amorphous, Isomorphism, Polymorphism and Pseudomorphism. 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 olivine group, pyroxene group, amphibole group, feldspar group, mica group, quartz group and spinel group. *Paragenesis and mode of alteration:* Silicates, oxides, carbonates, sulphates and halides.

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. De Jong,W.F.,(1955), General crystallography, Freeman.
6. Deer, W., Howie, R.A. & Zussman, J., (1996), The Rock forming minerals. Longman.
7. Hans-Rudolt Wenk and Andrei Bulakh.,(2004), Minerals – Their constitution and origin. Cambridge University Press.
8. Hurlbut.C.C, (1961), Dana's Manual of Mineralogy, New York
9. Hutchison, C.S., (1974), laboratory handbook of Petrographic Techniques. John Wiley.
10. Joseph .V.Smith., (1982), Geometrical and structural crystallography. John Wiley& sons.
11. Keith Frye.,(1974), Modern Mineralogy. Prentice-Hall.Inc New Jersey.
12. Klein, C and Hurbut, Jr., C.S. (1993), Manual of Mineralogy. John Wiley.
13. Kerr.P.F. (1959), Optical Mineralogy, McGraw Hill, Tokyo.
14. Martin.J.Burger.,(1970), Contemporary Cyrstallography. McGraw-Hill book company.
15. Oliver and Boyd. Dana,E.S.(1962),Text book of Mineralogy Revised by Ford,W.E.Wiley.
16. Phillips, Wm, R. & Griften, D.T., (1986), Optical Mineralogy, CBS edition.
17. Phillips,F.C.,(1963),Introduction to crystallography, Thomas Nelson.
18. Phillips,W.J..&N.,(1980), An introduction to mineralogy for geologist. John Wiley& sons.
19. Putnis Andrew., (1992), Introduction to Mineral Science, Cambridge University Press.

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.

18AGC04 – 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. Theories on the origin and evolutionary history of Life. Fossilization process and the nature of fossil record. Definitions for Species, index fossil, cosmopolitan species, fossil assemblage, fossil diversity, phylogeny. Types of biozones. Geological times cale. Morphological classification and Nomenclature. Cladistics. Species evolution, proliferation and extinction through time.

Unit II

Invertebrate Paleontology I

Morphology, taxonomy, age, distribution and ecological niches of Anthozoa, Trilobita, Graptoloidea, Porifera, Bryozoa.

Unit III

Invertebrate Paleontology II

Morphology, taxonomy, age, distribution and ecological niches of Brachiopoda, Bivalvia, Gastropoda, Cephalopoda, and Echinoidea.

Unit IV

Vertebrate Paleontology

Evolutionary history of Reptilian, Avian, Piscean, and Amphibian fauna. Evolution of mammals. Evolution of horse, elephant and human. Functional morphology.

Unit V

Paleontological applications

Introduction to palynology, micropaleontology, ichnology, Taphonomy and basin analysis. Applications of palaeontology in palaeoclimatic and palaeoenvironmental studies, age fixation and stratigraphic correlation, hydrocarbon exploration.

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
18AGP01 - 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. 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. Colour enhancement and gem testing.
9. Determination of relative relief (RI) of minerals by Becke-line test.
10. Determination of sign of elongation of minerals.
11. Determination of pleochroic scheme of minerals.
12. Determination of optic sign of uniaxial and biaxial minerals.
13. Determination of extension angle and its types.
14. Identification of rock forming minerals in hand specimens.
15. Mineralogical calculations.
16. Chemical examination of Industrial and ore minerals.

Palaeontology

Morphological descriptions, systematics and illustrations of representative 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 GautamMitra. 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.

18AGC05 - 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

Energy and the Mantle heat engine: Forms of energy - Flow and Transformation of Energy- Heat Flow in the Earth (Pressure and Temperature variations with depth) – Mantle melting and magma generation –Volatile fluids in melts – Nature of volatiles – solubility of volatiles in silicate melts – Exsolution of volatiles from a melt. Chemical dynamics of melts and crystals Textures: Primary textures (Rates of Nucleation, growth, and diffusion – Nucleation at Preferred sites – compositional zoning – crystallization sequence – differential movement of crystals and melt- cumulative textures- volcanic textures crystal /melt interactions) –Secondary textures – exsolution – secondary reactions and replacements- deformation.

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: The IUGS classification – 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 – Granitoid rocks – Continental rift associations bimodal and alkaline rocks – Alkaline orphans (mostly in stable cratons) - Lamprophyres.

Unit – IV

Concept of Metamorphism: The limits of metamorphism – Metamorphic agents and changes – Temperature, Pressure, Deviatoric stress, and Metamorphic fluids. 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 recrystallisation- 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, 2ndEdti., (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 Perason Pretice 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

18AGC06 – SEDIMENTOLOGY

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

Definition and principles of Sedimentology. Development of Sedimentology as an interdisciplinary subject of geoscience. Time and space in Sedimentology. Completeness of sedimentary record. Primary and indirect modes of data acquisition in Sedimentology.

Unit II

Rock cycle. Processes of sediment genesis, transport and deposition. Physical, chemical and biological sedimentary structures. Sediment texture – classification of unconsolidated sediments, siliciclastics, carbonates, evaporates, volcanoclastics, and miscellaneous types.

Unit III

Controlling factors of sedimentation – Tectonics, eustatic cycles, climate and sediment influx. facies concepts. facies association, facies succession, depositional models. Facies successions formed under gravity, glacial, lacustrine, aeolian, fluvial, coastal and deep sea environments.

Unit IV

Classification of sedimentary basins. Diagenesis of sediments – Stages, zones and environments of diagenesis. Compaction, Porosity types and evolution, cementation, neomorphism, dissolution-recrystallization, dolomitization, and silicification. Palaeocurrent, heavy mineral and clay mineral analyses for provenance and basin analysis.

Unit V

An overview on Sedimentary basins of India. Applications of Sedimentology for palaeoclimatic and palaeoenvironmental interpretation. Study of sedimentary geochemistry for understanding depositional and diagenetic processes.

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

18AGC07 - 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-Chhotanagpur-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

18AGC08 - EXPLORATION GEOLOGY

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

Mobility: Geochemical cycle. Mobility and association of elements. Geochemical tracers-elements and isotopes. *Dispersion*: Primary and secondary geochemical dispersion patterns. Geochemical and metallogenic provinces. *Methods of geochemical exploration*: Lithochemical methods-Pedochemical methods-Atmochemical geobotanical and biogeochemical methods. Geochemical sampling techniques-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
18AGP02 - PETROLOGY AND SEDIMENTOLOGY

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 SiO2 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. Megascopic study of sedimentary rocks and their identification through characteristic features.
2. Granulometric analysis of unconsolidated sediments and interpreting their modes of transport, and environments of deposition.
3. Petrographic study of clastic and non-clastic rocks and interpreting textural properties, depositional environments and diagenesis.
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..

18AGC09 - ECONOMIC GEOLOGY

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 occurrences 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.

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

Introduction to ore microscopy, techniques, methods, textures and microstructures of ores, interpretation of ore texture and optical properties of common sulphide, oxide ore minerals; Industrial application of ore microscopy.

Text/Reference Books

1. Anthony Evans, (1993) Ore Geology and Industrial Mineral, Jhon 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 Rocis 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, Thosmson 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, MCGraw Hill,.

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

16. Park, C.F. and Macdiarmid, 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.

18AGC010 - 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.

18AGC011– APPLIED 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:* objectives, layout of the test and 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.

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

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

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

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

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

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

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

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

19. 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.

18AGC012 – ADVANCED 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, 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 uses. GIS application in Natural resource mapping. GPS principles 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

18AGP03 - 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

18AGP04 - 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.

Remote Sensing and GIS

Aerial Photography: Stereovision Test, Pocket &Mirror Steoscope-3D Observation, Demarcation of marginal informations, 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.

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..

18AGC013 - 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. Application of coal petrology. 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).

Unit II

Coal as a source rock in petroleum generation. Coal exploration and estimation of coal reserves. Indian coal reserves and production of coal in India. Coal bed methane – a new energy resource. Elementary idea about generation of methane in coal beds, coal as a reservoir and coal bed methane exploration.

Unit III

Petroleum Geology

Petroleum – its composition and Properties;. Origin (formation of Source rock Kerogen, organic maturation and thermal cracking of kerogen) and migration of petroleum. Reservoir rocks-porosity and permeability. Reservoir traps – structural, stratigraphic and combination traps. Oil field fluids – water, oil and gas.

Unit IV

Methods of prospecting for oil and gas (geological modeling); Elementary knowledge of drilling and logging procedures - Oil shale - An outline of oil belts of the world. Onshore and offshore petroliferous basins of India. Oil policy of India. Gas Hydrates: Exposure to gas hydrates and future prospective.

Unit V

Atomic Energy

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

ELECTIVE COURSES
18AGE01 - 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. Explosive 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.

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 evaluations 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.

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. Staheler A.N. and Strahler A.M. (1973). Environmental Geoscience-John Wiley & Sons., Venkatramiah, 1989 Engineering Geology.Wiley

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

18AGE02 - 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: 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.

Unit III

Petrological microscopes: Principles, Parts, Operation and application of Petrological microscope, Ore microscope and Scanning electron microscope. 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: 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.

Unit V

Instruments used for geochemical analysis: Basic concept and techniques of Atomic Absorption Spectrometer (AAS). Inductively Coupled Plasma - Atomic Emission Spectrometer (ICP-AES). X-Ray Diffraction (XRD). X-Ray Fluorescence (XRF) and Differential Thermal Analysis (DTA).

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 Mapping

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

18AGE03 - APPLIED STRATIGRAPHY

Course Objectives

- To impart knowledge about the concept of time in stratigraphy, Stratigraphic Nomenclature, Sequence Stratigraphy, Chemostratigraphy.
- To acquaint students with knowledge of biostratigraphic units, biogeographic zone, provinces, controlling factors, zonation and their time significance.
- To discuss geochronology and chronostratigraphy.
- To explain the global bio-events and boundary problems in stratigraphy.
- To know about the stratigraphical applications in hydrocarbon exploration.

Course Outcomes

- Students will acquire knowledge in stratigraphic nomenclature
- Understands the biostratigraphic units, zones and provinces, geochronology
- Exposure on the lines of global bioevents and boundary
- Understands about the stratigraphical applications.
- Apply the knowledge on global bioevents and boundary problems.

Unit I

Concept of time in stratigraphy – measuring time, radiometric age dating techniques and problems. Spatial and temporal scales of cycles in sedimentary records. Controls on the development of stratigraphic records. Recent developments in stratigraphy on Stratotypes, Global Boundary Stratotype Sections and Points (GSSP). Lateral variation and facies. Graphic representation of stratigraphic data, methods of stratigraphic correlation.

Unit II

International Code of Stratigraphic Nomenclature. Lithostratigraphy, Codes units, correlation and contacts. Biostratigraphy- units, biogeographic zone, provinces, controlling factors, zonation and their time significance. Geochronology. Chronostratigraphy - the ICS International Chronostratigraphic Chart, code and units.

Unit III

Sequence Stratigraphy - Definition, origin of sequence concepts. Facies, facies association, facies succession, Conformity, unconformity, offlap, parasequences, systems Tracts, Roles of tectonics, eustacy, sediment influx and climate in sequence development. Sequences in clastic and carbonate deposits.

Unit IV

Chemostratigraphy-definition, evolution of chemostratigraphic concepts, secular and cyclic variation of geochemical composition over time. Mobile and immobile elements. Geochemical indices, geochemical proxy, geochemical signature, marker, fingerprint, geochemical signals, positive and negative excursions, anomalies, enrichment and depletion, chemozone. Absolute and relative dating of chemozones, scales of correlation. Statistical distinction of depositional units. Applications in hydrocarbon exploration, reservoir characterization and stratigraphic correlation.

Unit V

Relative sea level fluctuations, recognition of sequence surfaces and sequence cycles through seismic and outcrop data. Dating sequences through fossils and Defining sequence surfaces through palaeontological, petrographic, mineralogical, geochemical and other methods. Seismic and outcrop based sequence modeling. Limitations of sequences. Global bio-events and boundary problems in stratigraphy.

Text / Reference Books

1. Cotillon, P. (1992). Stratigraphy. Springer
2. Doyle, P. & Bennett. M.R. (1996). Unlocking the Stratigraphic Record. John Willey.
3. Krishnan,M.S (1968), The Geology of India and Burma, C.B.S Publication & Distribution
4. Lemon R.Y (1990), Principles of Stratigraphy, Merrill Publishing Co.
5. Ramkrishnan, M. and Vaidhyanadhan, R. (2008). Geology of India, Volume I and II, Geological Society of India, Bangalore
6. Ravindrakumar (1985), Fundamentals of Historical Geology and Stratigraphy of India. Wiley Eastern ltd, New Delhi.
7. Robert, M. S. (1989). Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.
8. Rocha, R., Pais, J., Kullberg, J.C., Finney, S. (Eds.). (2014). First International Congress on Stratigraphy At the Cutting Edge of Stratigraphy. Springer
9. Wadia,D.N (1966), Geology of India, ELBS Tata McGraw Hill.

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

18AGE04 - 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, Climatic change and global warming, Kyoto 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

18AGE05-ENVIRONMENTAL GEOLOGY

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.

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 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 Mineral Resource Energy. Geothermal 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 – Geoecosystems 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 sones, 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

18AGE06 - 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.

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
18GS01 - EARTH SYSTEM SCIENCE

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:

Sea waves, Tides, Ocean currents, Geological work of seas and oceans, Tsunami and its causes, Warning system and mitigation.

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
Biosphere:

Origin of life, Evolution of life through ages, Geological time scale, biodiversity and its conservation. Natural Resources: Renewable and non-renewable resources, Mineral and fossil fuel resources and their geological setting, mining of minerals and conservation, effect of mining on surface environment

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

18AGS02 – 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. Conjunctive use of surface and groundwater.

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 Distributers, 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

18GS03 – 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.

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.

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. Karanh R.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 Kindesley, 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-Heinemanu 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

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18GS04 - 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. Study of 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.

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.

Text / Reference Books

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

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.

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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

18GS05-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. 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.

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.

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.

18AGPJ 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.