The University of Burdwan

Syllabus for 1-Year / 2-Years Postgraduate Course
in
Geology
under Curriculum and Credit Framework for Postrgraduate Programmes (CCFUP) as per NEP, 2020
with effect from 2026-27

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1. Introduction

The National Education Policy (NEP) 2020 envisions a transformative higher education system that promotes academic excellence, multidisciplinary learning, research, innovation, and skill development. In line with this vision, the University Grants Commission (UGC) has introduced the Curriculum and Credit Framework (CCF) to enhance the quality, flexibility, and outcome-based approach of postgraduate education.

The present postgraduate syllabus in Geology has been designed in accordance with the recommendations of NEP 2020 and the UGC Curriculum and Credit Framework. The curriculum aims to provide advanced knowledge in Earth Sciences through an integration of theoretical concepts, laboratory training, field-based learning, research methodology, and scientific communication. It emphasizes experiential learning, analytical thinking, ethical research practices, and the application of modern geological techniques for addressing contemporary scientific and societal challenges.

Geology is an interdisciplinary science that encompasses the study of the Earth's materials, processes, resources, and environment by integrating concepts from geophysics, geochemistry, hydrology, environmental science, and other allied disciplines. Accordingly, the programme provides a balanced combination of core courses, specialized electives, field geology, research methodology, term paper, dissertation, and seminar presentation, enabling students to acquire both fundamental understanding and advanced professional competence.

Special emphasis has been given to field investigations, geological mapping, laboratory analysis, instrumentation, data interpretation, scientific writing, and dissertation work, thereby strengthening research aptitude and technical skills. The curriculum also promotes multidisciplinary learning through elective courses in emerging areas of Earth Sciences and encourages students to develop innovative solutions to geological, environmental, and resource-related problems.

The programme aims to produce competent geoscientists equipped with advanced disciplinary knowledge, research capability, professional ethics, leadership qualities, and lifelong learning skills. On completion of the programme, postgraduates will be well prepared for higher research, academia, government organizations, geoscientific industries, environmental consultancy, and other professional careers in Earth Sciences.

2. Semester-wise detailed course curriculum

SEMESTER-I

COURSE TYPE	COURSE CODE	COURSE TITLE	Credit	Lecture	Tutorial	Practical/ Viva	Full Marks	Distribution of Marks		
								Theory	Pr. /Tuto/ Viva	IA
Major/Core Course	PG2GEOL1011 (400-499)	Research Methodology	6	4	2	0	75	60	0	15
Major/Core Course	PG2GEOL1012 (400-499)	Term Paper (Should be opted from pool of courses.)	6	4	0	2	75	40	20	15
Major/Core Course	PG2GEOL1013 (400-499)	Field Geology (Structural Geology Mapping / Economic Geology)	6	0	0	6	75		60 (Submission of field note, field report & Viva)	15
Major/Core Course	PG2GEOL1014 (400-499)	Hydrogeology	6	4	2	0	75	60	0	15
Minor Course	PG2GEOL1021 (300-399)	Groundwater Geology	4	3	0	1	75	40	20	15
Total in Semester- I			**28**				**375**			

SEMESTER- II

COURSE TYPE	COURSE CODE	COURSE TITLE	Credit	Lecture	Tutorial	Practical/ Viva	Full Marks	Distribution of Marks		
								Theory	Pr. /Tuto/ Viva	IA
Major/Core Course	PG2GEOL2011 (400-499)	Exploration Geology	6	4	2	0	75	60	0	15
Minor Course	PG2GEOL2021 (300-399)	Natural Hazards and their Mitigation	4	3	1	0	75	60	0	15
Dissertation	PG2GEOL2091 (400-499)		12	0	0	12	225	Seminar Presentation, Preparation & submission of Research Project/Dissertation-135 + Viva-90		
Total in Semester- II			**22**				**375**			

OR

COURSE TYPE	COURSE CODE	COURSE TITLE	Credit	Lecture	Tutorial	Practical/ Viva	Full Marks	Distribution of Marks		
								Theory	Pr. /Tuto/ Viva	IA
Major/Core Course	PG2GEOL2011 (400-499)	Exploration Geology	6	4	2	0	75	60	0	15
Major/Core Course	PG2GEOL2012 (400-499)	Mineral Beneficiation & Mineral Economics	4	3	1	0	75	60	0	15
Major/Core Course	PG2GEOL2013 (400-499)	Hydrogeology	4	3	1	0	75	60	0	15
Major/Core Course	PG2 GEOL2014 (400-499)	Environmental Geology	4	3	1	0	75	60	0	15
Minor Course	PG2GEOL2021 (300-399)	Natural Hazards and their Mitigation	4	3	1	0	75	60	0	15
Total in Semester- II			**22**				**375**			
TOTAL CREDITS / MARKS			**178**				**3075**			

SEMESTER I

RESEARCH METHODOLOGY (PG2GEOL1011) (Cr. 6 (L:4 T:2 P:0))

Course Objectives: To introduce the principles and ethics of scientific research. To equip students with skills for designing and executing geological research projects. To provide hands-on experience in data collection, analysis, and interpretation using relevant software. To train students in effectively communicating research through writing and presentations. To foster academic integrity and critical thinking.

Course Learning Outcomes: Upon completion, students will be able to: Formulate: A research problem and a structured plan. Apply: Appropriate geological research methods for data collection. Analyze: Data using statistical and geospatial tools. Communicate: Research findings in scientific reports and presentations. Adhere to ethical standards in research. Understand the importance of academic integrity and avoid plagiarism. Engage with the geological community and contribute to scientific discourse.

Course Content

Unit 1: Introduction to Scientific Research and its Philosophy 12 Lectures

Concept and definition of Research: academic research, basic and fundamental research, applied research, theoretical, conventional and experimental research; Concepts and needs of research hypothesis; Research proposal and concepts; developing research proposal in the field of geosciences; research approach and identifying gap areas from literature review; problem formulation and statement of research objective. Ethics in Research - Plagiarism, data fabrication, copyright, intellectual property rights, and authorship. Introduction to the concept of Open Science and FAIR principles (Findable, Accessible, Interoperable, Reusable).

Unit 2: Formulating a Research Problem and Literature Review 12 Lectures

Literature survey and review, use of digital library, online resource; necessity of review of literatures; Problem formulation and statement of research objective; Developing of bibliography; Concepts on plagiarism, ISSN and ISBN numbers, impact factors and citation index of research articles and assessing the quality of research articles.

Unit 3: Research Design and Data Collection in Geology 15 Lectures

Research Design - Types of research designs relevant to geology: Field-based research: Geological mapping, stratigraphic logging, structural measurements. Laboratory-based research: Geochemical analysis, petrography, micropaleontology. Experimental research: Simulating geological processes in a lab. Remote sensing and GIS-based research: Using satellite imagery and geospatial data. Sampling Techniques - Random, systematic, stratified, and cluster sampling. Data Collection Methods in Geology Primary Data: Field notes, sample collection, photographic documentation, GPS data. Secondary Data: Geological maps, borehole logs, seismic data, published datasets.

Unit 4: Data Analysis and Interpretation 13 Lectures

Introduction to working principles, concepts, sample preparation, applications and limitations of: Transmitted-and reflected-light microscopes, Differential Thermal Analyser (DTA), XRD, Scanning Electron Microscope (SEM), ICP-MS, XRF, EPMA, Mass spectrometer, FTIR, Transmission Electron microscope (TEM), Mössbauer spectroscopy, Ion probe, Raman Spectroscopy, AAS, SHRIMP, INAA, TIMS, OSL and Fission Track (FT) Dating.

Unit 5: Scientific Communication and Report Writing 10 Lectures

Structure of a Scientific Report/Paper - IMRaD format (Introduction, Methods, Results, and Discussion). Writing the Abstract, Introduction, and Literature Review. Writing the ethodology and Results Sections. Writing the Discussion and Conclusion. References and Appendices. Oral and Poster Presentations - Designing effective slides and posters, public speaking skills, and communicating complex geological concepts to a diverse audience.

SUGGESTED READINGS

- Kothari, C.R. 2004. Research Methodology: Methods and Techniques. New Age International Publishers.
- Kumar, R. 2019. Research Methodology: A Step-by-Step Guide for Beginners. SAGE Publications.
- Ram, C.R. 2023. Research Methods in Earth Science. Springer Nature.
- Bjornerud, E. 2017.
- Reading the Rocks: A guide to the rocks, fossils, and landscapes of the Earth. W.W. Norton & Company. (For a philosophical and practical perspective on geological research).
- Journals: Journal of the Geological Society of India, Current Science, Proceedings of the Indian National Science Academy.

TERM PAPER (PG2GEOL1012) (Cr. 6 (L:4 T:0 P:2))

TO BE OPTED FROM POOL OF COURSES:

- **INTRODUCTION TO GEOPHYSICS**
- **OCEANOGRAPHY & MARINE GEOLOGY**
- **CLIMATOLOGY**
- **HISTORY OF THE EARTH**
- **PLANETARY GEOLOGY**
- **GROUNDWATER MANAGEMENT & WATER QUALITY**
- **SOIL GEOLOGY**

FIELD GEOLOGY (FIELD ANALYSIS OF GEOLOGICAL STRUCTURES & MINE VISIT) (PG2GEOL1013) (Cr. 6 (L:0 T:0 P:6))

Course Objective:

Following the stratigraphic principles, this fieldbased skill enhancement course will train students in establishing succession of geological units and events observed in nature.

Course Learning Outcomes:

- Application of the Principle of Uniformitarianism in field.
- Basement cover relationships - identifications and interpretations.
- Establishing order of superposition of geological units especially with the help of fossils.

Unit 1: Mine Visit

Onsite Study of underground and opencast mine including principles of underground mapping/ Bench mapping.

Unit 2

Field Identification and Measurement of Geological Structures

- Recognize and classify primary and secondary **geological structures** in the field (e.g., bedding, joints, faults, folds).
- Use **compass-clinometer** and other tools for accurate measurement of **strike**, **dip**, and **plunge**.

Unit 3

Geological Mapping and Cross-Section Construction

- Conduct **structural mapping** of outcrops and rock exposures.
- Prepare detailed **geological maps** and **cross-sections**, recording spatial relationships of structures.

Unit 4

Analysis and Interpretation of Structural Data

- Collect and analyze **field data** to interpret the geometry, orientation, and kinematics of structures.
- Use **stereonets** and other graphical methods for plotting and synthesizing structural information.

HYDROGEOLOGY (PG2GEOL1014) (Cr. 6 (L:5 T:0 P:1))

Course Objectives:

Water is a basic life supporting system. The rise in global population and the quest for better living standard has greatly stressed the water resources. The course content primarily focuses on groundwater, which being easily available is amenable to greater exploitation. Thus, this course aims to enable students to acquire knowledge about the physical and chemical attributes, occurrence, movement, and exploration of the groundwater resources.

Course Learning Outcomes:

- The students can access the occurrence of groundwater, water bearing properties of formations,aquifer types and aquifer parameters.
- They can develop an idea about construction, design and development of water wells,
- Aquifer parameter estimation and the science of groundwater flow under different conditions.
- The students will use the concepts of groundwater exploration.

Unit 1: Introduction and basic concepts **10 Lectures**

Scope of hydrogeology and its societal relevance
Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration, and subsurface movement of water. Rock properties affecting groundwater, Vertical distribution of groundwater, Types of aquifer, aquifer parameters, anisotropy, and heterogeneity of aquifers

Unit 2: Groundwater flow **15 Lectures**

Darcy's law and its validity, Intrinsic permeability and hydraulic conductivity, Groundwater flow rates and flow direction Laminar and turbulent groundwater flow

Unit 3: Well hydraulics and Groundwater exploration **15 Lectures**

Basic Concepts (drawdown; specific capacity etc.), Elementary concepts related to equilibrium and non-equilibrium conditions for water flow to a well in confinedand unconfined aquifers. Surface-based groundwater exploration methods Introduction to subsurface borehole logging methods.

Unit 4: Groundwater chemistry **20 Lectures**

Physical and chemical properties of water and water quality, Introduction to methods of interpreting groundwater quality data using standard graphical plots. Sea water intrusion in coastal aquifers.

Unit 5: Groundwater management **15 Lectures**

Surface and subsurface water interaction, Groundwater level fluctuations, Basic concepts of water balance studies, issues related to groundwater resources development and management, Rainwater

harvesting and artificial recharge of groundwater, Brief idea about groundwater pollution and its mitigation

Determination of hydraulic gradient/slope from water table depth data.

SUGGESTED READINGS:

- Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
- Davis, S. N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.
- Karanth K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co.Ltd.
- Raghunath, H. M. 1998. Groundwater, New Age International Publishers, New Delhi, 563.
- Fetter, C. W. Applied Hydrology, CBS publisher and distributer.

GROUNDWATER GEOLOGY (PG2GEOL1021) (Cr. 4 (L:3 T:0 P:1))

Course Objectives:

Water is a basic life supporting system. The rise in global population and the quest for better living standard has greatly stressed the water resources. The course content primarily focuses on groundwater, which being easily available is amenable to greater exploitation. Thus, this course aims to enable students to acquire knowledge about the physical and chemical attributes, occurrence, movement, and exploration of the groundwater resources.

Course Learning Outcomes:

- The students can access the occurrence of groundwater, water bearing properties of formations,aquifer types and aquifer parameters.
- They can develop an idea about construction, design and development of water wells,
- aquifer parameter estimation and the science of groundwater flow under different conditions.
- The students will use the concepts of groundwater exploration.

Unit 1: Introduction and basic concepts **10 Lectures**

Scope of hydrogeology and its societal relevance, Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration, and subsurface movement of water. Rock properties affecting groundwater, Vertical distribution of groundwater, Types of aquifer, aquifer parameters, anisotropy, and heterogeneity of aquifers

Unit 2: Groundwater flow **10 Lectures**

Darcy's law and its validity, Intrinsic permeability and hydraulic conductivity, Groundwater flow rates and flow direction Laminar and turbulent groundwater flow.

Unit 3: Well hydraulics and Groundwater exploration **10 Lectures**

Basic Concepts (drawdown; specific capacity etc.), Elementary concepts related to equilibrium and non-equilibrium conditions for water flow to a well in confinedand unconfined aquifers.

Unit 4: **5 Lectures**

Groundwater level fluctuations and artificial recharge of groundwater

Unit 5: Groundwater chemistry **10 Lectures**

Physical and chemical properties of water and water quality, Introduction to methods of

interpreting groundwater quality data using standard graphical plots. Sea water intrusion in coastal aquifers.

SUGGESTED READINGS:

- Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
- Davis, S. N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.
- Karanth K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co.Ltd.
- Raghunath, H. M. 1998. Groundwater, New Age International Publishers, New Delhi, 563.
- Fetter, C. W. Applied Hydrology, CBS publisher and distributer.

POOL OF COURSES FOR SEMESTER VII TERM PAPER (PG2GEOL1012)
(Cr. 6 (L:6 T:0 P:0))

INTRODUCTION TO GEOPHYSICS

Course Objective:

The course aims to give a foundational understanding of Earth's interior, plate tectonics and heat flow, and to introduce the basic principles of seismic, gravity, magnetic, electrical, IP, MT and GPR methods for subsurface exploration.

Course Learning Outcomes:

Students will be able to explain key ideas such as seismic wave propagation, isostasy, geothermics, gravity and magnetic anomalies, and electrical resistivity in relation to rocks and structures. They will also be able to briefly describe how major geophysical methods (seismic, gravity, magnetic, resistivity/VES, SP, IP, MT, GPR) are laid out in the field and identify suitable geological, environmental or engineering problems for each technique.

Content

Unit 1

Introduction to Seismic waves; Seismic waves through earth's interior; Geoid, Isostasy: Modern Concepts, Apparent Polar Wonder, Continental Drift; Plate Motion, Geothermics; Heat Flow pattern of the Earth.

Unit 3

Gravity–Densities of Rocks and Gravity Anomalies; Geomagnetism and Palaeomagnetism; Magnetic survey.

Unit 4

Electrical Properties: Resistivity surveying; Vertical Electrical Sounding (VES); Electrical Imaging.

Unit 5

Spontaneous (Self) Potential Method; Induced Polarisation; Magneto-telluric Surveying (MT); Ground Penetration Radar.

Suggested Reading:

- M. B. Dobrin, and C. H. Savit, 1988, Introduction to Geophysical Prospecting, McGraw-Hill.
- F.S. Grant, and G.F. West, 1965, Interpretation Theory in Applied Geophysics McGraw Hill, New York. 3. L. Y. R. Murthy, and D. C. Mishra, 1989, Interpretation of Gravity and Magnetic Anomalies in Space and
- Frequency Domain, AEG publication, Hyderabad, India
- L. L. Nettleton, 1976, Gravity and Magnetics in Oil Prospecting, McGraw Hill. 5. D. S. Parasnis, 1966, Mining Geophysics, Elsevier.
- 6. H.P. Patra, and K. Mallick, 1980, Geosounding Principles Vol. II, Time-varying geoelectric soundings. Amsterdam: Elsevier.
- 7. W. Lowri, Fundamentals of Geophysics, Cambridge University Press.
- 8. A. E. Mussett, M. A. Khan, 2000, Looking into the earth: An introduction to geological geophysics, Cambridge University Press.
- 9. W. M. Telford, L. P. Geldart, and R. E. Sheriff, 1990, Applied geophysics. Cambridge University Press.

OCEANOGRAPHY & MARINE GEOLOGY

Course Objective:

This course provides foundational knowledge of oceanography and marine geology, covering ocean basin origins, physiography, circulation patterns, waves, tides, coastal dynamics, and marine resources.

Course Learning Outcomes:
Students will explain ocean floor features, wind-driven and thermohaline circulation, wave properties including tsunamis, tidal models, and coastal processes like shoaling, beaches, and estuaries. They will describe anthropogenic impacts on shorelines and identify types of marine resources (physical, biological, mineral) along with UNCLOS laws governing their exploitation.

Unit 1
Introduction to the Oceans. Oceanography – the concept, brief historical review; Origin of Ocean Basins; Physiography of the Ocean Floor

Unit 2
Wind and Ocean Circulation. Atmospheric Processes - Air Pressure, Coriolis Deflection, General Wind Circulation; Surface Ocean Currents; Deep-Ocean Circulation; Thermohaline. Conveyer Belt - impact on Global Climate

Unit 3

Waves in the Ocean Properties of Ocean Waves; Wave Motions; Standing Waves, Internal Waves, Tsunamis

Unit 4

Tides Origin of the Tides, Equilibrium Model of Tides, Dynamic Model of the Tides; Tidal Currents.

Unit 5

The Dynamic Shoreline. Coastal Water Movement, Shoaling Waves and Refraction, Circulation in the Surf Zone; Beaches; Coastal Dunes; Barrier Islands; Deltas; Estuaries; Lagoons; Mangrove swamps; Anthropogenic impact on the Coastline

Unit 6

Marine Resources. Types of marine resources; Physical, energy, biological and non-extractive resources; Mineral resources; Laws of the sea.

SUGGESTED READINGS:

- Gross, M. G., 1977. Oceanography: A view of the earth.
- Pinet, Paul R., 2016. Invitation to Oceanography, Seventh edition. Jones & Bartlett Learning.
- Webb, P., Introduction to Oceanography. Free Download at http://rwu.pressbooks.pub/webboceanography

CLIMATOLOGY & CLIMATE CHANGE

Course Objective:

This course introduces the fundamental structure, composition, and dynamics of the Earth's atmosphere, along with key climatic phenomena like monsoons, ENSO, and global circulation patterns essential for understanding India's agrarian economy. It emphasizes the causes, greenhouse gas effects, and societal impacts of climate change, including pollution and polar expeditions, with focus on environmental awareness and sustainable development.

Course Learning Outcome:

The students will learn the basic structure & composition of the atmosphere which is important for our survival. Climate change is one of most important parameters which is affecting the society and its development. The course will provide the basic understanding of the climate and climate change. We are all aware of the fact that the monsoon affects our agriculture and thus the agrarian economy of India. It is thus felt that the analysis and concept of monsoon should be known common man in general and the students in particular.

Unit 1

Scope and aim of Climatology; Climate and weather; Structure of the atmosphere, troposphere, stratosphere, mesosphere, ionosphere and exosphere; Composition of the atmosphere; Atmospheric boundary layers, lapse rate.

Unit 2

Insolation; Solar radiation; Factors affecting distribution of insolation, latitudinal and seasonal variation of insolation; Temperature of the atmosphere, distribution of temperature, inversion of temperature; Air pressure, distribution of air pressure, variation in air pressure; General circulation of the atmosphere, surface wind system, wind belts, humidity, fog and clouds, cloud formation; types of precipitation.

Unit 3

Air masses, Monsoon, Jet streams, El Nino Southern Oscillation (ENSO), Cyclones, and Anticyclones, ITCZ; Western disturbances; SW and NE monsoons.

Unit 4

Climate change; Causes of Climate Change, Green House gases and effect, Pollution in the atmosphere; Arctic and Antarctic Indian Expeditions.

Suggested Reading:

- Rudiman, W.F., 2001. Earth's climate: past and future. Edition 2, Freeman Publisher.
- Rohli, R.V., and Vega, A.J., 2007. Climatology. Jones and Barlatt.
- S. D. Willett, 2006, Tectonics, Climate, and Landscape Evolution, Geological Society of America Publication.
- R.S. Bradley, Paleoclimatology: Reconstructing Climates of the Quaternary, Academic. Press. 3. D.S. Lal, 2003, Climatology. Sharda Pustak Bhawan
- C. D. Ahrens, 2001, Essentials of Meteorology: An Invitation to the Atmosphere. Publisher Brooks/Cole/Thomson Learning.

HISTORY OF THE EARTH

Course Objective

The objective of this course is to make a student aware of the rhythm and pulses of earth's physical, chemical and biological changes as recorded in rock sequences, their chemistry and fossil content respectively. To understand the future changes expected one must decipher the pattern of variations in these parameters through ages. This course designed to make student aware of the history of various components of the Earth System.

Course Learning Outcomes

By completeing this course the students will be well versed with the pattern of changes occuring in various spheres of earth through geological time from Barysphere to mesosphere, lithosphere, cryosphere, atmosphere, biosphere etc.

A comprehensive understanding of all these sphere through geological time will enable the student to understand future of our planet.

Unit 1

Physical History of Earth: Origin of Planet Earth, Early evolution of Earth's Atmosphere, Origin of Oceans. Earliest supercontinent and history of its breakup. Basic concepts of plate Tectonics and Wilson Cycle.

Unit 2

Chemical History of Earth: Early differentiation of the Earth's layers. Mechanical and compositional layers of earth. Abundance of elements. Comparison of Earth's chemistry with other planets of our Solar System.

Unit 3

Biological History of Earth: Origin of life on Earth. Earliest record of life in Earth's rocks. Evolution from single cell to multicellular life. Ediacara Fauna and its significance. Evolution of skeletal organisms. A brief overview of Palaeozoic, Mesozoic and Cenozoic life.

Unit 4

Evolution of continents and oceans: Continental drift and sea floor spreading. History of Atlantic, Pacific and Indian Oceans. Separation of Gondwanaland.

Suggested Reading:

- Hazen, Robert (2012). Robert Hazen 2012. The Story of Earth: The first 4.5 billion years. Penguin.
- Knoll, A.H. Life on a young Planet. Princeton Science Library

PLANETARY GEOLOGY

Course Objective

The background knowledge on the planetary material, interiors as well as processes including the planet formation processes

Course Learning Outcomes

1. Origin of planets
2. Planetary features including those of the exoplanets
3. Remote sensing techniques in planetary characterization
4. Impact cratering- rates and causes
5. Planetary surface processes and interiors

Unit 1

Introduction to Planetary Geology, Planetary configuration and description The Big Bang & Early Solar System History

Unit 2

The Era of Planetary Formation Impact Craters: A Geologic Process and Markers of Time Meteorites: the building blocks of planets- Classification and types Asteroids.

Unit 3

Techniques in planetary science- Remote techniques The Moon: Formation & Evolution, Internal structure, composition, water on the moon

Mercury and the MESSENGER Mission Venus: Earth's Twin?

Unit 4

The early Earth and primary geochemical differentiation, the first billion years and emergence of life, the great oxidation event and search for life beyond earth Planetary surface and interior processes, Atmosphere Mars- Results from the Curiosity Rover, Climatic Evolution & Prospects for Life

Unit 5

Saturn: Rings & Strange Moons, structure Pluto Exoplanets and search for earth like planets Practicals Geologic events on earth.

Geological features seen on aerial photographs (emphases on Moon and Mars). Satellite imagery data of planets and data interpretation Planetary feature on earth and moon.

Suggested reading:

- Rossi, A.P. & van Gesselt, S. (Eds) (2017). Planetary Geology, Springer.

GROUNDWATER MANAGEMENT & WATER QUALITY

Course Objective

To understand about the fundamentals of: groundwater management and water quality issues.

Learning outcome

The course will impart basic understanding about: groundwater science; aquifers; groundwater flow and groundwater management principles and practices. The concepts of water quality;water quality parameters and criteria for portable and irrigation use; contamination and pollution and graphical representation of the water quality data.

Unit 1

Water science and its societal relevance, Hydrologic cycle and interaction of the surface and subsurface water, Vertical distribution of subsurface water.

Unit 2

Introduction to the concept of porosity and permeability, classification of rocks and sediments as aquifer, aquitard, aquiclude and aquifuge. Types of Aquifer, concept of the piezometric surface and water table and aquifer parameters.

Unit 3

Introduction to Darcy's law and the concept of : static water level, pumping water level, drawdown, radius of influence, cone of depression, specific capacity etc.

Unit 4:

Introduction to: the basic concept of water balance and the groundwater resources estimation; principles of the groundwater management; rainwater harvesting and artificial recharge to groundwater; aspects of watershed management as an integral part of groundwater management.

Unit 5: Introduction to the concept of water quality, contamination, pollution and water quality parameters: Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), organoleptic; physical; chemical; radioactive and bacteriological parameters. The criteria for portable and irrigation use and graphical representation of the water quality data.

Suggested readings:

- Todd, D. K. (1980). Groundwater hydrology, 2ed. John Wiley. (p. 535).
- Karanth, K.R. (1987). Groundwater: Assessment, Development and management, Tata McGrawHill Pub. Co. Ltd.
- Freeze, R. A., & Cherry, J. A. (1979). Groundwater (p. 604). New Jersey: Prentice Hall Inc Englewood cliffs.
- Syed Tajdarul Hassan. 2017. Introduction to Hydrology. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: https://epgp.inflibnet.ac.in/ahl.php?csrno=448
- Shekhar Shashank . 2017. Aquifer Properties. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: https://epgp.inflibnet.ac.in/ahl.php?csrno=448

SOIL GEOLOGY

Course Objective:

1. Students will be given idea about different soil forming processes
2. Modern soils and key pedofeatures
3. Geological record of fossil soils

Course Learning Outcomes:

1. Students will have idea on soil forming processes
2. Students will come to know recognizing criteria of palaeosol
3. Students will have idea on geological record of fossil soils

Unit 1

Soil forming processes: Chemical weathering, major buffer maintaining ocean/atmosphere/biosphere O2 and CO2, new compounds/minerals of greater volume and lower density; Oxidation; Carbonation; Hydrolysis; Hydration; Base Exchange; Chelation; Microbial Weathering.

Unit 2

General soil forming regimes: Gleization; podzolization; lessivage; ferrallitizatin; calcification; salinization. Soil forming processes: Physical weathering, loosening and particle size reduction; pressure release; thermal expansion; growth of foreign crystal.

Unit 3

Modern soils and key pedofeatures: Soil structures; horizons; roots; Fe-Mn mottles and concretions; pedogenic carbonate.

Unit 4

Introduction to palaeopedology and palaeosols; role of factors controlling palaeosol formation- parent material, climate, vegetation, topography, time. Introduction to soil taxonomy and palaeosol taxonomy.

Unit 5

Micromorphology: Thin section analysis of palaeosols. Geochemistry: molecular rations; chemical weathering indices. Stable isotope geochemistry: carbon13 and oxygen18 system for vegetation, temperature, pCO2. Diagenetic overprinting in fossil soils: compaction; oxidation of organic matter; cementation; illitization.

Unit 6

Geological record of fossil soils- Precambrian palaeosols- evolution of palaeoatmospheric conditions. Geological record of fossil soils.

SUGGESTED READING:

- Retallack, G.J. (2001) Soils of the Past: An Introduction to Paleopedology (2nd edition): Oxford, Blackwell Science, Ltd., 416 p.
- Birkeland, P.W. (1999) Soil and Geomorphology. Oxford University Press (430 pp.).
- Bullock, P., Fedoroff, N., Jongeroius, A., Stoops, G. & Tursina, T. (1985) Handbook of Soil Thin Section Description. Waine Research Publication, Wolverhampton (152 pp.).
- Sheldon, N.D. & Tabor, N.J. (2009) Quantitative palaeoenvironmental and paleoclimatic reconstruction using paleosols. Earth-Science Reviews 95, 1–52.
- Stoops, G. (2003) Guidelines for analysis and distribution of soil and regolith thin sections. Soil Sci. Soc. Am., Madison, Wisconsin, 184 pp.
- Soil Survey Staff, (2006) Key to Soil Taxonomy, 10th ed. USDA Natural Resources Conservation Service, Washington D.C.(341 pp.)
- Bhattacharyya T., Sarkar, D., Pal, D. K. (Eds.) Soil Survey Manual. NBSSLUP
- Publication No 146.

INSTRUMENTATION TECHNIQUES IN EARTH SCIENCES

Unit 1

Basics of instrumentation in Geology. Quality, Precision, Accuracy, calibration and standards.

Unit 2

Introduction to instrumental techniques in Geology (SEM, XRF, EPMA, EBSD, ICPMS, SIMS, TIMS, IRMS, Raman Spectroscopy).

Unit 3

Application of different techniques in different fields of Earth Sciences/Geology.

Unit 4

Handling and processing of data generated through different techniques.

Suggested Reading:

- Faure, G., Mensing. T.M. 2005. Isotopes. Principles and Applications, Wiley
- S. J. B. Reed. Electron Microprobe Analysis and Scanning Electron Microscopy in Geology. 2nd Edition, Cambridge Univ. Press

SEMESTER II

EXPLORATION GEOLOGY (PG2GEOL2011) (Cr. 6 (L:5 T:0 P:1))

Course Objectives:

To understand the concept of exploration, different techniques used to find out a hidden mineral treasure, advantages and disadvantages of these techniques and to estimate the content of the treasure.

Course Learning Outcomes:

The students will be able to judge the suitability of a technique for a particular type of deposit and its limitation. They will be aware of the required information that to be collected for reserve estimation.

Content:

Unit 1 **10 Lectures**

Concept of mineral exploration, stages of mineral exploration and tasks accomplished under them. Surface and subsurface methods of exploration.

Unit 2 **20 Lectures**

Introduction of various methods of geophysical prospecting – magnetic, gravity, electrical,seismic and radiometric methods. Brief outline of various well logging techniques.

Unit 3 **20 Lectures**

Geochemical methods for mineral exploration- lithogeochemical, pedogeochemical, hydrogeochemical, biogeochemical and atmogeochemical methods

Unit 4 **10 Lectures**

Geobotanical and photogeochemical methods.

Unit 5 **15 Lectures**

Drilling, sampling methods and estimation of reserves.

SUGGESTED READINGS:

- Brooks, R.R., Geobotany and Biogeochemistry in Mineral Exploration, Harper and Row.,New York.
- Ginzburg, I.I., Principles of Geochemical Prospecting, Pergamon Press, London
- Hawkes, H.E. and Webb. J.S.: Geochemistry in Mineral Exploration, Harper and Row, New York.
- Levinson, A.A.: Introduction to Exploration Geochemistry, Applied Publishing Ltd. Calgary
- Malyuga, D.P: Biochemical Methods of prospecting. Cosultants Bureau. New York
- Reedman, J.H.: Techniques in Mineral Exploration, Applied Science Publishers Ltd. London
- Benjamin F., Howell, JR.: Introduction to Geophysics, McGraw-Hill Book Co., New York
- Dobrin, M.B.: Introduction to Geophysical Prospecting, McGraw-Hill Book Co., New York
- Kearey, P. andBrooks, M. An Introduction to Geophysical Exploration, ELBS, Blackwell Scientific
- Publication
- Nettleton, L.L., Geophysical Prospecting for Oil. Mc-Graw-Hill Book Co., New York 11 Parasnis, D.S. Principles of Applied Geophysics. Methuen and Co, London.
- Telford, W.M. Geldart, L.P., Sheriff, R.E. and Keys, D.A.: Applied Geophysics. Cambridge University Press.
- William Lawrie. Fundamentals of Geophysics, Cambridge University Press.

NATURAL HAZARDS AND THEIR MITIGATION (PG2GEOL2021)

(Cr. 4 (L:3 T:1 P:0))

Course objective

- To provide students an understanding the need for studying the natural hazards management
- Develop an understanding about the various types disasters
- To create awareness about disaster prevention and risk reduction
- To gain knowledge on Climate Change Adaptation

Course learning Outcome

- Understand the need and significance of studying disaster management
- Understand the different types of disasters and causes for disasters
- Gain knowledge on the impacts of disasters on environment and society

Unit 1 **5 Lectures**
What are natural hazards?
Unit 2 **5 Lectures**
What is Mitigation?
Unit 3 **5 Lectures**
Natural hazards and mitigation types.
Unit 4 **15 Lectures**
Geophysical hazards: Earthquake, volcanic eruption, landslides, tsunamis.
Unit 5 **10 Lectures**
Hydrological hazards: Avalanches, floods
Unit 6 **5 Lectures**
Climatological hazards: Extreme temperatures, draughts, wildfires
Unit 7 **10 Lectures**
Meteorological hazards: Severe storms, cyclones, hurricanes, typhoons and tornadoes.
Unit 8 **5 Lectures**
Biological hazards: Disease outbreaks and epidemics.

SUGGESTED READINGS:

- Gábor Mezősi, 2022. Natural Hazards and the Mitigation of their Impact, Springer.
- Singh, R. B., 2006. Natural Hazards & Disaster Management- Vulnerability and Mitigation, Rawat Publications.
- Daniel J. Alesch, Lucy A. Arendt, William J. Petak, 2012. Natural Hazard Mitigation Policy: Implementation, Organizational Choice, and Contexual Dynamics, Springer Netherlands.

DISSERTATION (PG2GEOL2091) **(Cr. 12 (L:0 T:0 P:12))**

Course Objectives:

To give the students an idea of Research Methodology, data acquisition techniques, analysis of data andrepresentation of the data both verbally and printed form.

Course Learning Outcomes:

Students will be equipped with a first-hand training of reproduction of an original work that will makehim ready for future whether it is in job to submit a project report or in his research work.

Dissertation: Preparation and submission of research project/Dissertation, Seminar presentation.

EXPLORATION GEOLOGY (PG2GEOL2011) (Cr. 6 (L:5 T:1 P:0))

Course Objectives:

To understand the concept of exploration, different techniques used to find out a hidden mineral treasure, advantages and disadvantages of these techniques and to estimate the content of the treasure.

Course Learning Outcomes:

The students will be able to judge the suitability of a technique for a particular type of deposit and its limitation. They will be aware of the required information that to be collected for reserve estimation.

Content:

Unit 1 **10 Lectures**

Concept of mineral exploration, stages of mineral exploration and tasks accomplished underthem. Surface and subsurface methods of exploration.

Unit 2 **20 Lectures**

Introduction of various methods of geophysical prospecting – magnetic, gravity, electrical,seismic and radiometric methods. Brief outline of various well logging techniques.

Unit 3 **20 Lectures**

Geochemical methods for mineral exploration- lithogeochemical, pedogeochemical, hydrogeochemical, biogeochemical and atmogeochemical methods

Unit 4 **10 Lectures**

Geobotanical and photogeochemical methods.

Unit 5 **15 Lectures**

Drilling, sampling methods and estimation of reserves.

Suggested Readings:

- Brooks, R.R., Geobotany and Biogeochemistry in Mineral Exploration, Harper and Row.,New York.
- Ginzburg, I.I., Principles of Geochemical Prospecting, Pergamon Press, London
- Hawkes, H.E. and Webb. J.S.: Geochemistry in Mineral Exploration, Harper and Row, New York.
- Levinson, A.A.: Introduction to Exploration Geochemistry, Applied Publishing Ltd. Calgary
- Malyuga, D.P: Biochemical Methods of prospecting. Cosultants Bureau. New York
- Reedman, J.H.: Techniques in Mineral Exploration, Applied Science Publishers Ltd. London
- Benjamin F., Howell, JR.: Introduction to Geophysics, McGraw-Hill Book Co., New York
- Dobrin, M.B.: Introduction to Geophysical Prospecting, McGraw-Hill Book Co., New York
- Kearey, P. andBrooks, M. An Introduction to Geophysical Exploration, ELBS, Blackwell Scientific
- Publication
- Nettleton, L.L., Geophysical Prospecting for Oil. Mc-Graw-Hill Book Co., New York 11 Parasnis, D.S. Principles of Applied Geophysics. Methuen and Co, London.
- Telford, W.M. Geldart, L.P., Sheriff, R.E. and Keys, D.A.: Applied Geophysics. Cambridge University Press.
- William Lawrie. Fundamentals of Geophysics, Cambridge University Press.

MINERAL BENEFICIATION AND MINERAL ECONOMICS (PG2GEOL2012)

(Cr. 4 (L:3 T:0 P:1))

Course objective:

The course objective is to provide a possibility to understand mineral processes for ores, industrial minerals, recycling products and mineral fuel. The theoretical aspects of common mineral processing techniques are covered. Students will have an idea about equipment utilized nowadays in mining and extractive metallurgy practices. They will be acquainted with the solid separation principles when applied to ores and minerals, from the mine down to concentrates production.

Course learning Outcome:

After completion of the course, the student will be able to:

- Understand the basic principles of mineral separation processes and the respective equipment used;
- Analyze reasons for selection of processes based on raw material properties,
- Make a logical link between applied mineralogy, mineral processing and economics of metal production

Unit 1 **5 Lectures**

Beneficiation- necessity, importance, advantages;

Unit 2 **5 Lectures**

Crushing- Construction and operational features of primary and secondary crushers. Jaw and Gyratory crushers, cone and roll crushers.

Unit 3 **5 Lectures**

Grinding theory, Ball and Rod mills- construction and operation.

Unit 4 **10 Lectures**

Laboratory sizing and industrial screening, rake, spiral and hydrocyclone classifiers.

Unit 5 **10 Lectures**

Size, specific gravity and surface property dependent beneficiation processes-gravity concentration- theory and practice of Jigging, heavy media separation and flowing film concentration. Froth flotation. Drying and dewatering.

Unit 6 **10 Lectures**

Mineral economics and its concept. Specialities inherent in mineral industry. Strategic, critical and essential minerals. Reserve- resources classification; Conservation and substitution, National Mineral Policy.

Suggested Readings:

- Barry A. Wills, Mineral Processing Technology, Pergamon Press, New York
- Gaudin, A.M., Principles of Mineral Dressing. McGraw-Hill, London.
- Taggart A.F., Handbook of Mineral Dressing. Wiley, New York
- Chatterjee, K.K. An Introduction to Mineral Economics, Wiley Eastern Limited, Calcuuta.
- Hussain, A.M.: The Economics and Economic Geology of the Mineral Industries, Applied

Publishers.

- Sinha, R.K. and Sarma, N.L., Mineral Economics. Oxford and IBH Publishing Co.

GEODYNAMICS (PG2GEOL2013) (Cr. 4 (L:3 T:1 P:0))

Unit 1: Introduction 15 Lectures

Definition. Continents and oceans. Continental and oceanic crust. Internal processes of earth; Concept of lithosphere and asthenosphere. Physical character of lithosphere and asthenosphere. Concept of plate. Concept of hotspot and mantle plume. Ophiolites. Palaeomagnetism.

Unit 2: Plate and Plate boundaries 20 Lectures

Plates: Physical character of plates. Macro and microplates. Plate boundaries: types, character, Identification of boundaries. Movement of plates along boundaries. Plate velocities. Volcanic arcs, island arcs, trenches, accretionary prisms, oceanic ridges, transform faults. Magmatism in oceanic ridges and in subduction zones.

Unit 3: Continental Drift, Seafloor spreading and Plate tectonics 10 Lectures

Wegner Continental drifts hypothesis and its evidences. Continental position in the past; Distribution of plates inthe Earth.

Unit 4: Palaeomanetism 15 Lectures

Palaeomagnetism and motion of plates; Driving mechanisms of plates. Plate tectonics and mantleconvection; Supercontinents and their breakup and assembly. Wilson cycle.

SUGGESTED READINGS:

- Turcotte, D.L.and Schubert,G. Geodynamics. Second Edition. Cambridge
- Kearey,p., Klepeis, K.A.,and Vine,F.J.(2009). Global Tectonics. Third edition.Wiley-Blackwell,Oxford.

ENVIRONMENTAL GEOLOGY (PG2GEOL2014) (Cr. 4 (L:3 T:1 P:0))

Course objective:

This course aims to investigate the interaction between geologic principles, environments, humans, and the Earth. The course is designed to provide the students with the tools necessary to interpret change in global environments. The use of fundamental geologic knowledge is investigated to encourage critical thinking & effective problem-solving methodologies for sustainability in human-landscape interactions.

Course learning Outcome:

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

- Describe the scientific method as applied in the earth sciences;
- Demonstrate about common earth materials and their relationship to environmental hazards;

- Explain how the occurrence and formation of earth resources and significant environmental effects caused by their extraction, processing, and use;
- Describe the major sources of water, soil, and sediment pollution and methods for their management;
- Explain the causes and effects of global climate change;
- Demonstrate an understanding of data collection, interpretation, and concluding specific to natural andanthropogenic processes that are relevant to humans and the environment;
- Scrutinize how the earth system process is instrumental in formulating public policy or law to deal with a variety of environmental problems and the delineate role of geoscientist in management of solving environmental problems.

Unit 1 **5 Lectures**

Our place in the environment: What is environmental geology? Global degradation of environment, tragedy of population explosion, humans as agents of geological change, fundamental concepts of environmental geology.

Unit 2 **5 Lectures**

Earth Systems and cycles: energy, hydrological, biogeochemical, oxygen, nitrogen, rock

Unit 3 **5 Lectures**

Hazardous geological processes: types of hazards, prediction and warning, role of geoscientists.

Unit 4 **5 Lectures**

Resource: nature of earth resources, renewable and non-renewable resources, issues in resource management, earth resources and society.

Unit 5 **5 Lectures**

Land- its use and management: Land-a resource, land capability mapping, assessment of impact of land use.

Unit 6 **5 Lectures**

Soil types and conservation: nature of soil, soil profile, classification of soils, soil loss-a global concern, soil conservation.

Unit 7 **10 Lectures**

Mineral resources: mineral consumption and reserves, conservation of mineral resources, impact of mining activity on the environment, environmental management in mining.

Unit 8 **5 Lectures**

Alternative sources of energy: energy crisis, strategies for planning our energy, future alternatives to fossil fuels, nuclear energy option.

Unit 9 **10 Lectures**

Nature and effects of air-, water-, noise- and land pollution, disposal of solid wastes, role of geology in waste disposal.

Unit 10 **5 Lectures**

Environmental Impact Assessment: concept of EIA, identification of impacts, evaluation of impacts, environmental management plan, preparation environmental impact ststement.

SUGGESTED READINGS:

- Kellar, E. A., 2011, Environmental Geology, Prentice Hall, Pearson Education, Inc. New Jersey
- Murck, B. W., Skinner, B. J. and Potter, S. C. Environmental Geology, John Wiley and Sons, Inc.
- Lal, D. S. Climatology, Chaitanya Publ. House.
- Ristinen, R. A., Energy and the Environment, John Wiley and Sons, Inc.

NATURAL HAZARDS AND THEIR MITIGATION (PG2GEOL2021)

(Cr. 4 (L:3 T:1 P:0))

Course objective

- To provide students an understanding the need for studying the natural hazards management
- Develop an understanding about the various types disasters
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Programme Outcome

A. **Postgraduate Attributes**: The quality and feature or characteristics of an individual, including the knowledge, skills, attitudes, and values that are expected to be acquired by a postgraduate through studies at the higher education institution.

Some of the characteristic attributes that a postgraduate should demonstrate:

i) Disciplinary knowledge
ii) Communication Skills
iii) Critical thinking
iv) Problem solving
v) Analytical reasoning
vi) Research-related skills vii) Cooperation/Teamwork viii) Scientific reasoning
ix) Reflective thinking
x) Information/digital literacy xi) Self-directed learning
xii) Multicultural competence
xiii) Moral and ethical awareness/reasoning
xiv) Leadership readiness/qualities
xv) Lifelong learning

B. **Qualification descriptors:** The generic outcomes and attributes expected for the award of a particular type of qualification (for e.g. a bachelor's degree or a bachelor's degree with honours).

Qualification descriptors for a Postgraduate degree

(a) Demonstrate (i) a systematic, extensive and coherent knowledge and understanding of an academic field of study as a whole and its applications, and links to related disciplinary areas/subjects of study; including a critical understanding of the established theories, principles and concepts, and of a number of advanced and emerging issues in the field of study; (ii) procedural knowledge that creates different types of professionals related to the disciplinary/subject area of study, including research and development, teaching and government and public service; (iii) skills in areas related to one's specialization and current developments in the academic field of study, including a critical understanding of the latest developments in the area of specialization, and an ability to use established techniques of analysis and enquiry within the area of specialization.

(b) Demonstrate comprehensive knowledge about materials, including current research, scholarly, and/or professional literature, relating to essential and advanced learning areas pertaining to the chosen disciplinary areas (s) and field of study, and techniques and skills required for identifying problems and issues relating to the disciplinary area and field of study.
(c) Demonstrate skills in identifying information needs, collection of relevant quantitative and/or qualitative data drawing on a wide range of sources, analysis and interpretation of data using methodologies as appropriate to the subject(s) for formulating evidence-based solutions and arguments.
(d) Use knowledge, understanding and skills for critical assessment of a wide range of ideas and complex problems and issues relating to the chosen field of study.
(e) Communicate the results of studies undertaken in an academic field accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s) of study.
(f) Address one's own learning needs relating to current and emerging areas of study, making use of research, development, and professional materials as appropriate, including those related to new frontiers of knowledge.
(g) Apply one's disciplinary knowledge and transferable skills to new/unfamiliar contexts and to identify and analyze problems and issues and seek solutions to real-life problems.
(h) Demonstrate subject-related and transferable skills that are relevant to some of the job trades and employment opportunities.