UNIVERSITY OF DELHI

Bachelor of Science (Hons.) Geology

(Effective from Academic Year 2019-20)

Revised Syllabus approved by

Date: Academic Council No.
Date: Executive Council No.

Applicable for students registered with Regular Colleges

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PREAMBLE

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes. The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of B.Sc.(Hons) Geology offers through innovative classroom teaching with ICT tools, models and demonstrations, a conceptual background to the geological processes which generally operate at time scales ranging from days to billions of years and their products. Intensive field training exposes the students to the geological processes that operate in nature and their relevance to natural resource exploration, understanding natural hazards and environmental changes. The programme addresses current environmental issues of societal televance, such as climate change providing a deep time understanding of climate change in the geological past. Sustainable development of natural resources keeping a balance between economics and environment is what a geology graduate student is expected to learn. The programme also provides a basic understanding of geo-heritage sites and their protection and preservation for posterity. As a whole, the students are expected to understand the nature of lithosphere, hydrosphere, atmosphere, and biosphere interactions and their final products from a deep time perspective.

The University of Delhi hopes the LOCF approach of the programme B.Sc. (Hons) Geology will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

1. INTRODUCTION TO PROGRAMME

The objective of any programme at Higher Education Institute is to prepare students for the society at large. Keeping this in view a Learning Outcome-based Curriculum Framework (LOCF) is adopted in B.Sc. (Hons.) Geology course. The LOCF has been adopted to strengthen student's experiences as they engage themselves in the programme of their choice.

Being a fast economically developing country with increasing population, the nation is faced with innumerable problems related to depleting natural resources, acute shortage of energy, natural disasters and many types of environmental hazards. Two-third of Indian subcontinent lies in the seismic zones of moderate to severe intensity. Solution and management of many of these problems can be met by understanding the earth more intensively and extensively, which could be achieved by pursuing the course in Geology. It is an exciting course related to natural science and has both fundamental as well as applied utility especially in the large ticket infrastructure projects.

The course aims at inculcation of values and knowledge within students that will make them well-being responsible citizen and encourage in critical thinking with skills of employability.

2. LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK IN PROGRAMME B.SC. (HONS.) GEOLOGY

2.1NATURE AND EXTENT OF THE PROGRAMME IN B.SC. (HONS) GEOLOGY

After the successful completion of B.Sc. (Honours) course pupil are eligible for admission to courses M. Sc./ M. Tech /M. Sc. Tech. in Geology, Applied Geology, Remote Sensing, Geo-informatics, Environmental science, Petroleum geology and Mining Engineering at various universities of India and abroad. They are also eligible for admission to B. Ed. at various universities. Geology is one of the optional subjects for civil services, Forest Services and similar examinations.

PG degree in Geology, make them eligible for UPSC examination to enter Geological Survey of India (GSI) and the Central Ground water Board (CGWB). Para-military forces are also in constant need of Geologists. Experienced and well educated Geologists can also apply for top positions in the government, industry and education sector.

2.2 AIMS OF BACHELOR DEGREE PROGRAMME IN B.SC. (HONS) GEOLOGY

Through innovative classroom teaching with through ICT tools models and demonstrations, students develop an ability of perceiving the geological processes which generally operate at time scales ranging from days to billions of years with the fundamental premise that the present is the key to past. It prepares students to develop their logical thinking and communication skills with the science based imaginative perception. Ethical societal context of applied geology in economic as well as environmental context is the fundamental balance which a geology graduate student is expected to acquire. Propagating their thoughts through presentations and participation in various related societies enhance their cultural- social-national centric thought.

3. GRADUATE ATTRIBUTES IN B.SC. (HONS) GEOLOGY

Geology is everywhere in our daily lives and finds its potential application in various fundamental spheres of life including exploration and management of mineral and energy resources, ground water and surface water, land use and environment hazards viz. floods, landslides and seismicity,

volcanoes and tsunamis, environmental protection by monitoring waste disposal sites including nuclear waste etc. Understanding our Earth has never been more important. Because Earth science is so intertwined with our daily lives, our discipline evolves as the years go by; responding to the needs of what society compels us to understand.

These diverse needs require a strong understanding of the basic concepts and principles of Earth science. Although the times change and the applications vary, understanding the basic composition of geologic materials, their origins, and how the planet acts as a physical and chemical system is imperative in understanding Earth. Everything from climate change, to the abundance of groundwater, to the frequency of large storms and earthquakes, to the location and cost of extracting rare elements from Earth is relevant. It is a simple fact that as the complexity of these challenges increases, the need for well-educated geologists to provide scientific data and advice in extracting, conserving and managing earth's natural resources will assume more and more importance.

4. QUALIFICATION DESCRIPTORS FOR GRADUATES B.SC. (HONS) GEOLOGY

Bachelor's degree in Geology with Honours will be awarded to students who will have

1. Systematic understanding of key aspects of the subject, including acquisition of coherent and detailed knowledge
2. Ability to employ the established techniques of analysis in the discipline in order to resolve problems
3. Devise arguments and ideas to solve problems, which are in the forefront of the subject
4. Describe and comment on recent topics of research and advancement in the subject
5. Apply the methods and techniques to extend their knowledge to initiate and carry out projects, to address questions to achieve a solution
6. Communicate information, ideas, problems and solutions to both professionals and non-professionals.

5. PROGRAMME LEARNING OUTCOMES IN B.SC. (HONS) GEOLOGY

Through innovative classroom teaching with through ICT tools models and demonstrations, students develop an ability of perceiving the geological processes which generally operate at time scales ranging from days to billions of years with the fundamental premise that the present is the key to past. It prepares students to develop their logical thinking and communication skills with the science based imaginative perception. Ethical societal context of applied geology in economic as well as environmental context is the fundamental balance which a geology graduate student is expected to acquire. Propagating their thoughts through presentations and participation in various related societies enhance their cultural- social-national centric thought.

PSO1. To understand the nature and origin of various component of earth system including planetary objects, its origin, its components and operative processes in past and present

PSO2. To acquire theoretical framework for understanding the nature of geological material including rocks, minerals and fossils

PSO3. To integrate observations and theory for describing natural geological process in past and present as well to understand the time scales of geological processes

PSO4. To apply the knowledge of the material and processes in mineral and energy exploration, oceanography, soil and water resource

PSO5. To apply the knowledge gained through field work for greater understanding of earth and related phenomena.

6. STRUCTURE OF B.SC. (HONS) GEOLOGY

6.1CREDIT DISTRIBUTOR FOR B.SC. (HONS) GEOLOGY

Details of courses under B.Sc. (Honours)

Course	*Credits Theory+ Practical
I. Core Course	
(14 Papers)	14X4 = 56
Core Course Practical/Tutorial*	
(14 Papers)	14X2 = 28
II. Elective Course	
(8 Papers)	
A.1. Discipline Specific Elective	4X4 = 16
(4 Papers)	
A.2. Discipline Specific Elective Practical/Tutorial	4X2 = 8
(4 Papers)	
B.1. Generic Elective/ Interdisciplinary	4X4 = 16
(4 Papers)	
B.2. Generic Elective Practical/Tutorial	4X2 = 8
(4 Papers)	
III. Ability Enhancement Courses	
1. **Ability Enhancement Compulsory**	
(2 Papers of 2 credit each)	2X2 = 4
Environmental Science	
English/MIL Communication	
2. **Ability Enhancement Elective** (Skill Based)	2x2 = 4

6.2 SEMESTER-WISE DISTRIBUTION OF COURSES

SEMESTER	COURSE OPTED	COURSE NAME	CREDIT
I	Ability Enhancement: compulsory course – I	Communicative English	2
	Core Course - I	Earth System Science	4
	Core Course – I (Practical)		2
	Core Course - II	Mineral Science	4
	Core Course – II (Practical)		2
	Generic Elective – I	GE – I	4
	Generic Elective – I (Practical)	GE – I	2
		Total Credit	**20**
SEMESTER	**COURSE OPTED**	**COURSE NAME**	**CREDIT**
II	Ability Enhancement: compulsory course – II	Environmental Science	2
	Core Course – III	Elements of Geochemistry	4
	Core Course – III (Practical)		2
	Core Course – IV	Structural Geology	4
	Core Course – IV (Practical)		2
	Generic Elective – II	GE – II	4
	Generic Elective –II (Pactical)		2
		Total Credit	**20**
SEMESTER	**COURSE OPTED**	**COURSE NAME**	**CREDIT**
	Core Course – V	Igneous Petrology	4
	Core Course – V (Practical)		2
	Core Course – VI	Sedimentary Petrology	4

III	Core Course – VI (Practical)		2
	Core Course – VII	Palaeontology	4
	Core Course – VII (Practical)		2
	Generic Elective – III		4
	Generic Elective – III (Practical)		2
	Skill Enhancement	Field Work-I	2
		Total Credit	**26**
SEMESTER	**COURSE OPTED**	**COURSE NAME**	**CREDIT**
IV	Core Course – VIII	Metamorphic Petrology	4
	Core Course – VIII (Practical)		2
	Core Course – IX	Stratigraphic Principles and Indian Stratigraphy	4
	Core Course – IX Practical		2
	Core Course – X	Hydrogeology	4
	Core Course – X (Practical)		2
	Skill Enhancement Course – II	Field Work – II	2
	Generic Elective – IV	GE – 4	4
	Generic Elective – IV (Practical)		2
		Total Credit	**26**
SEMESTER	**COURSE OPTED**	**COURSE NAME**	**CREDIT**
V	Core Course – XI	Economic Geology	4
	Core Course – XI (Practical)		2
	Core Course – XII	Geomorphology	4
	Core Course – XII (Practical)		2
	Discipline Specific Elective – I	DSE – I	4
	Discipline Specific Elective – I (Practical)		2

	Discipline Specific Elective – II	DSE – II	4
	Discipline Specific Elective – II (Practical)		2
		Total Credit	**24**
SEMESTER	**COURSE OPTED**	**COURSE NAME**	**CREDIT**
VI	Core Course – XIII	Engineering Geology	4
	Core Course – XIII (Practical)		2
	Core Course – XIV	Remote Sensing & GIS	4
	Core Course – XIV (Practical)		2
	Discipline Specific Elective – III	DSE – III	4
	Discipline Specific Elective (Practical – III)		2
	Discipline Specific Elective – IV	DSE – IV	4
	Discipline Specific Elective (Practical – IV)		2
		Total Credit	**24**
Grand Total of Credits in Six Semesters			**140**

7. COURSES FOR PROGRAMME B.SC. (HONS) GEOLOGY

EARTH SYSTEM SCIENCE

(GEOL CC1)

Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective (2-3)

Introduction to the Earth and other planets in the solar system in terms of surface features and Processes; Principles of earth system studies.

Interactions between lithosphere, hydrosphere, biosphere and atmosphere

Course Learning Outcomes

After completion of this course students will be able to understand and comprehend the connectivity and dynamics of atmosphere, lithosphere, and hydrosphere of the Earth. A thorough

understanding of Geology, its various branches and overall scope of Earth Science will be possible through this course.

Unit 1

Holistic understanding of dynamic planet 'Earth' through Astronomy, Geology, Meteorology and Oceanography; Introduction to various branches of Earth Sciences.

General characteristics and origin of the Universe, Solar System and its planets. The terrestrial and Jovian planets. Interior of the earth. Meteorites and Asteroids

Earth in the solar system - origin, size, shape, mass, density, rotational and revolution parameters and its age. E Earth's Magnetic Field and its origin. Palaeomagnetism.

Suggested Readings:

Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.
Gross, M. G. (1977). Oceanography: A view of the earth.
Emiliano, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.

Unit 2

Plate Tectonics: Concept of plate tectonics, sea-floor spreading and continental drift
Earthquake and earthquake belts; Volcanoes- types, products and their distribution.

Suggested Readings:

Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.
Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.

Unit 3

Hydrosphere and Atmosphere: Oceanic current systems. Warm and cold ocean currents and their distribution. Impact of ocean currents on climate; Wave erosion and beach processes; Atmospheric circulation; Weather and climatic changes; Earth's heat budget.

Soils - processes of formation, soil profile and soil types.

Suggested Readings:

Gross, M. G. (1977). Oceanography: A view of the earth.
Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.

Unit 4

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

Principals of stratigraphy; Physiographic divisions of India

Suggested Readings:

Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.
Gross, M. G. (1977). Oceanography: A view of the earth.
Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.
Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi.

Practicals

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

Study of distribution of major dams on map of India and their impact on river systems

Study of major ocean currents of the World

References

1. Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.

2. Gross, M. G. (1977). Oceanography: A view of the earth.

Additional Resources:

3. Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.

4. Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi.

Weekly Teaching Plan

Week 1
Holistic understanding of dynamic planet 'Earth' through Astronomy, Geology, Meteorology and Oceanography.

Week 2
Introduction to various branches of Earth Sciences.

Week 3
General characteristics and origin of the Universe, Solar System and its planets. The terrestrial and Jovian planets. Interior of the earth. Meteorites and Asteroids

Week 4
Earth in the solar system - origin, size, shape, mass, density, rotational and revolution parameters and its age. E Earth’s Magnetic Field and its origin. Palaeomagnetism.

Week 5
Plate Tectonics, Concept of plate tectonics, sea-floor spreading and continental drift

Week 6
Earthquake and earthquake belts and Volcanoes- types, products and their distribution.

Week 7
Hydrosphere and Atmosphere, Oceanic current systems. Warm and cold ocean currents and their distribution. Impact of ocean currents on climate.

Week 8
Wave erosion and beach processes, Atmospheric circulation, Weather and climatic changes.

Week 9
Earth's heat budget. Soils- processes of formation, soil profile and soil types.

Week 10
Nature of geologic records. Understanding the past from geologic records.

Week 11
Standard Geological time scale and introduction to the concept of time in geological studies. Introduction to geochronological methods and their application in geological studies

Week 12
History of development in concepts of uniformitarianism, Catastrophism and Neptunism.

Week 13
Principals of stratigraphy.

Week 14
Physiographic divisions of India

Teaching Learning Process
Lectures, Practicals, Seminars, Tutorials, Assignments

Assessment Methods
Tests, Quiz, Debates and presentations

Keywords
Atmosphere, Lithosphere, Hydrosphere, Biosphere, Planets

MINERAL SCIENCE

(GEOL CC2)

Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective (2-3)

To develop an understanding of minerals as pure and impure phases
Minerals as the building block of earth and planetary mass Basic understanding of crystallography and crystal chemistry

Course Learning Outcomes

1) Identify common rock-forming minerals in hand specimen and in thin section using diagnostic physical, optical, and chemical properties

(2) Learning about crystallography and to infer the environment of formation of minerals

(3) Minerals as a tool to understand Earth processes, Earth's Interior and Earth history

Unit 1

Rock forming minerals
Minerals-definition and classification, physical and chemical properties

***Suggested Readings**:*

Cornelis Klein and Barbara Dutrow, The manual of Mineral Science, Wiley Publication 2007

Unit 2

Crystal symmetry
Elements of crystal chemistry and aspects of crystal structures
Silicate and non-silicate structures; CCP and HCP structures
Composition of common rock-forming minerals

***Suggested Readings**:*

Deer W. A., Howie.R. A. and Zussman, J., An introduction to the rock forming minerals 1992

Cornelis Klein and Barbara Dutrow, The manual of Mineral Science, Wiley Publication 2007

Unit 3

Crystallography
Elementary ideas about crystal morphology in relation to internal structures Crystal parameters and indices
Crystal symmetry and classification of crystals in to six systems and 32 point groups
Stereographic projections of symmetry elements and forms

***Suggested Readings**:*

Cornelis Klein and Barbara Dutrow, The manual of Mineral Science, Wiley Publication 2007

Unit 4

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

***Suggested Readings**:*

Nesse W. D., Introduction to Optical mineralogy.2008, Oxford University Press.

Practicals
Study of physical properties of minerals in hand specimen
Silicates: Olivine, Garnet, Kyanite, Staurolite, Tourmaline, Serpentine, Talc, Muscovite, Biotite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite.
Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose quartz, Smoky quartz, Rock crystal.
Native Metals/non-metals, Sulfides, Oxides-Copper, Sulfur, Graphite, Pyrite, Corundum, Magnetite, Hydroxides, Halides, Carbonates, Sulfates, Phosphates: Psilomelane, Fluorite, Calcite, Malachite, Gypsum, Apatite.
Study of some key silicate minerals under optical microscope and their characteristic properties

References
1. Putnis A. Introduction to mineral Sciences, Cambridge publication, 1992

2. Cornelis Klein and Barbara Dutrow, The manual of Mineral Science, Wiley Publication 2007

3. Kerr P. F. Optical Mineralogy, 1959. McGraw-Hill.

4. Verma P. K., Optical mineralogy, CRC press 2009

5. Nesse W. D., Introduction to Optical mineralogy.2008, Oxford University Press.

6. Deer W. A., Howie.R. A. and Zussman, J., An introduction to the rock forming minerals 1992

Additional Resources: Dana's Manual of Mineralogy

Weekly Teaching plan

Week 1
Introduction to common Rock forming minerals.
Minerals-definition and classification, physical and chemical properties
Practical: Basic exercise to show different rock types comprises of different minerals.

Week 2
Minerals-definition and classification, physical and chemical properties
Introduction of Crystal symmetry concept. Elements of crystal chemistry.
Practical: Study of physical properties of minerals in hand specimen.
Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose quartz, Smoky quartz, Rock crystal.

Week 3
Aspects of crystal structures. Silicate and non-silicate structures; CCP and HCP structures
Practical: Study of physical properties of minerals in hand specimen.
Silicates: Olivine, Garnet, Kyanite, Staurolite, Tourmaline, Serpentine, Talc, Muscovite, Biotite, Quartz,Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite.

Week 4
Composition of common rock-forming minerals. Understanding of Crystallography.
Elementary ideas about crystal morphology in relation to internal structures
Practical: Study of physical properties of minerals in hand specimen.
Silicates: Olivine, Garnet, Kyanite, Staurolite, Tourmaline, Serpentine, Talc, Muscovite, Biotite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite.

Week 5
Crystal morphology in relation to internal structures. Crystal parameters and indices
Practical: Study of physical properties of minerals in hand specimen.
Native Metals/non-metals, Sulfides, Oxides-Copper, Sulfur, Graphite, Pyrite, Corundum, Magnetite

Week 6
Crystal symmetry and classification of crystals in to six systems and 32 point groups
Practical: Study of physical properties of minerals in hand specimen. Native Metals/non-metals, Sulfides, Oxides-Copper, Sulfur, Graphite, Pyrite, Corundum, Magnetite

Week 7
Crystal symmetry and classification of crystals in to six systems and 32 point groups
Practical: Study of hand specimen:
Hydroxides, Halides, Carbonates, Sulphates, Phosphates: Psilomelane, Fluorite, Calcite, Malachite, Gypsum, Apatite.

Week 8
Stereographic projections of symmetry elements and forms.
Practical: Study of hand specimen:
Hydroxides, Halides, Carbonates, Sulphates, Phosphates: Psilomelane, Fluorite, Calcite, Malachite, Gypsum, Apatite.

Week 9
Stereographic projections of symmetry elements and forms.
Practical: Study of some key silicate minerals under optical microscope and their characteristic properties

Week 10
Properties of light and optical microscopy
Practical: Study of some key silicate minerals under optical microscope and their characteristic properties

Week 11
Properties of light and optical microscopy
Practical: Study of some key silicate minerals under optical microscope and their characteristic properties

Week 12
Nature of light and principles of optical mineralogy
Practical: Study of some key silicate minerals under optical microscope and their characteristic properties

Week 13
Introduction to the petrological microscope and identification of common rock-forming minerals
Practical: Study of some wooden crystal model to understand crystal symmetry.

Week 14
Introduction to the petrological microscope and identification of common rock-forming minerals
Practical: Study of some wooden crystal model to understand crystal symmetry.

Teaching Learning Process

Lectures, Practicals, Seminar, Tutorials, Assignments

Assessment Methods

Tests, Quiz, Debates and Presentations

Keywords

Pure and impure phases, crystals, lattice, silicates, coordination number

SEDIMENTARY PETROLOGY

(GEOL CC3)

Core Course – (CC) Credits: Theory (4) Practical (2)

Course Objective (2-3)

To develop an understanding of s near-surface processes of the planet 'Earth
Learning to decode signatures of exogenic processes including climate and tectonics.

Course Learning Outcomes

Sedimentary rocks host all fossil fuels (coal, oil and gas), which is the driving force of modern civilization. Understanding basic processes of sedimentation (physical and chemical) including behaviour of fluids, fluid-grain interaction, structures formed thereof and processes control chemical sedimentation viz. carbonates, BIF, Phosphorite etc. is the goal of this course. The course will also aim for exposing students to different kinds of sedimentary rocks, their structures, textures and variability. Attempt will be made to provide students a holistic understanding of sedimentation process from deposition to diagenesis.

Unit 1

Origin of sediments
Weathering and sedimentary flux: Physical and chemical weathering, Role of climate and Tectonics. Soils and Palaeosols.
Suggested Readings
Prothero, D. R.,& Schwab, F. (2004).Sedimentary geology. Macmillan.
Sengupta, S. (1995) Sedimentary Geology, Elsevier

Unit 2
Sediment granulometry
Grain size scales Udden-Wentworth and Krumbein (phi) scale, particle size distribution; mean, median, mode. Environmental connotation; particle shape and fabric (Grain roundness and sphericity)
Suggested Readings:
Prothero, D. R.,& Schwab, F. (2004).Sedimentary geology. Macmillan.
Sengupta, S. (1995) Sedimentary Geology, Elsevier

Unit 3
Sedimentary textures, structures and environment
Fluid flow, sediment transport and sedimentary structures: Types of fluids, Laminar vs. turbulent flow, Particle entrainment, transport (bedload, saltation and suspension) and deposition. Inter- and Intra-bed sedimentary structures, Penecontemporaneous Deformation Structures (PCD) and Trace fossils.

Palaeocurrent analysis-Scalar and Vector attributes; Paleocurrents for different sedimentary environments

Suggested Readings:
Nichols,G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley Blackwell
Sengupta, S. (1995) Sedimentary Geology, Elsevier

Collinson, J. D. &Thompson, D. B. (1988) Sedimentary structures, Unwin-Hyman, London.

Unit 4

Varieties of sedimentary rocks
Siliciclastic rocks: Conglomerates, sandstones, mudrocks.
Carbonate rocks, controls of carbonate deposition, components and classification of limestone, dolomite and dolomitisation
Suggested Readings:
Nichols,G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley Blackwell
Tucker, M. E. (2006) Sedimentary Petrology, Blackwell Publishing.

Unit 5

Diagenesis
Concepts of diagenesis, Concept of pressure and thermal gradient,
Stages of diagenesis, Compaction and cementation. Siliciclastic and carbonate
Suggested Readings:
Nichols,G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley Blackwell
Prothero, D. R.,& Schwab, F. (2004).Sedimentary geology. Macmillan

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

References

1. Prothero, D. R.,& Schwab, F. (2004).Sedimentary geology. Macmillan.
2. Tucker, M. E. (2006) Sedimentary Petrology, Blackwell Publishing.
3. Collinson, J. D. &Thompson, D. B. (1988) Sedimentary structures, Unwin-Hyman, London.
4. Nichols,G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley Blackwell
5. Lewis, D.W. and McConchie, D., (1984) Practical sedimentology Wiley Blackwell

Weekly Teaching plan

Week 1
Introduction of subject: sediment; soil; Origin of sediments. Weathering and sedimentary flux: Physical and chemical weathering, Role of climate and Tectonics.
Practical: Intoduction to sedimentary rocks in hand specimen, Exercises on sedimentary structures

Week 2
Soils and Palaeosols. Sediment granulometry. Grain size scales Udden-Wentworth and Krumbein (phi) scale, particle size distribution; mean, median, mode.
Practical: Exercises on sedimentary structures, Primary, penecontemporaneous deformation and trace fossil sedimentary

Week 3
Environmental connotation; particle shape and fabric (Grain roundness and Sphericity)

Fluid flow, sediment transport and sedimentary structures: Types of fluids, Laminar vs. turbulent flow, Particle entrainment, transport (bedload, saltation and suspension) and deposition
Practical: Exercises on sedimentary structures

Week 4
Inter- and Intra-bed sedimentary structures, Penecontemporaneous Deformation Structures (PCD) and Trace fossils.
Practical: Study of physical properties of minerals in hand specimen.
Silicates: Olivine, Garnet, Kyanite, Staurolite, Tourmaline, Serpentine, Talc, Muscovite, Biotite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodality.

Week 5
Sedimentary textures, structures and environment
Practical: Particle size distribution and statistical treatment

Week 6
Sedimentary textures, structures and environment
Practical: Particle size distribution and statistical treatment

Week 7
Palaeocurrent analysis-Scalar and Vector attributes; Palaeocurrents for different sedimentary environments
Practical: Particle size distribution and statistical treatment

Week 8: Varieties of sedimentary rocks: Siliciclastic rocks: Conglomerates, sandstones, mudrocks.
Practical: Palaeocurrent analysis

Week 9: Varieties of sedimentary rocks: Siliciclastic rocks: Conglomerates, sandstones, mudrocks.
Practical: Paleocurrent analysis

Week 10
Carbonate rocks, controls of carbonate deposition, components and classification of limestone, dolomite and dolomitisation
Practical: Petrography of selected clastic and non-clastic rocks through hand specimens and thin sections

Week 11
Carbonate rocks, controls of carbonate deposition, components and classification of limestone, dolomite and dolomitisation.
Practical: Petrography of selected clastic and non-clastic rocks through hand specimens and thin sections

Week 12
Concepts of diagenesis, Concept of pressure and thermal gradient,
Practical: Petrography of selected clastic and non-clastic rocks through hand specimens and thin sections

Week 13
Stages of diagenesis, Compaction and cementation. Siliciclastic and carbonate
Practical: Petrography of selected clastic and non-clastic rocks through hand specimens and thin sections

Week 14

Stages of diagenesis, Compaction and cementation. Siliciclastic and carbonate.

Practical: Petrography of selected clastic and non-clastic rocks through hand specimens and thin sections

Teaching Learning Process

Lectures, Practicals, Seminar, Tutorials, Assignments

Assessment Methods

Tests, Quiz, Debates and Presentations

Keywords

Near surface process, sedimentation, clastic, non-clastic, environment, structure, facies

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STRUCTURAL GEOLOGY

(GEOL CC4)

Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective (2-3)

To have an understanding of the geometry of deformation of earth material
To identify these features in natural occurrence
To measure attributes of such features and to relate these to regional deformational context

Course Learning Outcomes

Structural geology essentially deals with the geometry, kinematics and dynamics of deformation of rocks. In response to the instability of the lithosphere produced by complex plate tectonic movements, continuous and discontinuous deformation takes place within the rocks in solid or semi-solid state, at different scales and at different depths, which manifests in a variety of complex structures in these rocks. The undergraduate CBCS course of structural geology will teach the students the different geometric features of deformation, different types of deformation-induced structures, basic techniques of measurement of different parameters in deformed rocks, and will also give them a glimpse of the underlying deformation processes and mechanisms.

Unit 1

Introduction to Structure and Topography
Understanding a topographic map; Effects of topography on structural features: Rule of V; Planar and linear structures; Concept of dip and strike, trend and plunge.

Suggested Readings:

Billings, M. P. (1987). Structural Geology, 4th edition, Prentice-Hall.
Park, R. G. (2004). Foundations of Structural Geology. Chapman & Hall.
Pollard, D. D. (2005). Fundamental of Structural Geology. Cambridge University Press.

Unit 2

Stress and strain in rocks

Concept of rock deformation: Definition of Stress and Strain, Stress tensor in 3D; Strain ellipses of different types and their geological significance.

Suggested Readings:

Davis, G. R. (1984). Structural Geology of Rocks and Region. John Wiley

Billings, M. P. (1987). Structural Geology, 4th edition, Prentice-Hall.

Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.

Unit 3

Folds

Fold morphology; Geometric and genetic classification of folds; Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding; Outcrop patterns of different fold structures.

Suggested Readings:

Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley

Billings, M. P. (1987). Structural Geology, 4th edition, Prentice-Hall.

Park, R. G. (2004) Foundations of Structural Geology. Chapman & Hall.

Unit 4

Foliation and lineation

Description and origin of foliations: axial plane cleavage and its tectonic significance; different types of foliations: crenulation cleavage, disjunctive cleavage, salty cleavage, schistosity, gneissosity etc.

Description and origin of lineation and relationship with major structures; stretching lineation and its relationship with strain.

Suggested Readings:

Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley

Billings, M. P. (1987). Structural Geology, 4th edition, Prentice-Hall.

Park, R. G. (2004) Foundations of Structural Geology.Chapman & Hall.

Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.

Unit 5

Fractures and faults

Geometric and genetic classification of fractures and faults; Effects of faulting on the outcrops; Geologic/geomorphic criteria for recognition of faults and fault plane solutions.

Joints – different types of joints and their geological significance – columnar joint, pinnate joint, plumose structure.

Suggested Readings:

Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley

Billings, M. P. (1987). Structural Geology, 4th edition, Prentice-Hall.

Park, R. G. (2004) Foundations of Structural Geology. Chapman & Hall.

Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.

Practicals

Basic idea of topographic contours, Topographic sheets of various scales.

Structural contouring and 3-point problems of dip and strike

Introduction to Geological maps: Drawing profile sections and interpretation of geological maps of different complexities

Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.)

Weekly Teaching plan

Week 1
Introduction to Structure and Topography. Understanding a topographic map; Effects of topography on structural features:
Practical: Exercises on Basic idea of topographic contours, Topographic sheets of various scales.

Week 2
Understanding a topographic map; Effects of topography on structural features: Rule of V; Planar and linear structures; Concept of dip and strike, trend and plunge.
Practical: Exercises on Basic idea of topographic contours, Topographic sheets of various scales.

Week 3
Stress and strain in rocks. Concept of rock deformation
Practical: Exercises on Basic idea of topographic contours, Topographic sheets of various scales.

Week 4
Concept of rock deformation: Definition of Stress and Strain, Stress tensor in 3D; Strain ellipses of different types and their geological significance.
Practical: Exercise based on Structural contouring and 3-point problems of dip and strike

Week 5
Folds
Fold morphology; Geometric and genetic classification of folds;
Practical: Exercise based on Structural contouring and 3-point problems of dip and strike

Week 6
Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding; Outcrop patterns of different fold structures.
Practical: Exercise based on Structural contouring and 3-point problems of dip and strike

Week 7
Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding; Outcrop patterns of different fold structures.
Practical: Exercise based on Structural contouring and 3-point problems of dip and strike

Week 8
Foliation and lineation
Description and origin of foliations: axial plane cleavage and its tectonic significance;
Practical: Introduction to Geological maps: Drawing profile sections and interpretation of geological maps of different complexities

Week 9
Different types of foliations: crenulation cleavage, disjunctive cleavage, slaty cleavage, schistosity, gneissosity etc
Practical: Introduction to Geological maps: Drawing profile sections and interpretation of geological maps of different complexities

Week 10
Description and origin of lineation and relationship with major structures; stretching lineation and its relationship with strain.

Practical: Introduction to Geological maps: Drawing profile sections and interpretation of geological maps of different complexities

Week 11

Description and origin of lineation and relationship with major structures; stretching lineation and its relationship with strain.
Practical: Introduction to Geological maps: Drawing profile sections and interpretation of geological maps of different complexities

Week 12

Fractures and faults; Geometric and genetic classification of fractures and faults;
Practical: Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.)

Week 13

Effects of faulting on the outcrops; Geologic/geomorphic criteria for recognition of faults and fault plane solutions.
Practical: Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.)

Week 14

Joints – different types of joints and their geological significance – columnar joint, pinnate joint, plumose structure.
Practical: Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.)

References

1. Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley
2. Billings, M. P. (1987) Structural Geology, 4th edition, Prentice-Hall.
3. Park, R. G. (2004) Foundations of Structural Geology. Chapman & Hall.
4. Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.
5. Ragan, D. M. (2009) Structural Geology: an introduction to geometrical techniques (4th Ed). Cambridge University Press (For Practical)
6. Laree F. H. (1962) Field Geology. McGraw

Teaching Learning Process

Lectures, Practicals, Seminar, Tutorials, Assignments

Assessment Methods

Tests, Quiz, Debates and Presentations

Keywords

Fold, fault, lineations, cleavage, stress, strain, orogeny

ELEMENTS OF GEOCHEMISTRY

(GEOL CC5)

Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective (2-3)

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

To relate mineralogy, geochemistry and bulk chemistry.

Course Learning Outcomes

By attending this course student will be able

1. To understand evolution of the early Earth from proto-planetary material and its differentiation to present day state.
2. To describe the composition of the Earth´s main geochemical reservoirs.
3. To understand how chemical weathering of minerals and rocks control the composition of sediments/soil and natural water.

Unit 1

Origin of chemical elements and stellar evolution. Abundance of elements in cosmos, solar system and earth. Meteorites, distribution of elements in core, mantle, crust.

Suggested Reading:

Mason, B (1986). Principles of Geochemistry. 3 rd Edition, Wiley New York.2. Rollinson H. (2007). Using geochemical data-evaluation. Presentation and interpretation. 2nd Edition. Publisher Longman Scientific & Technical.

Unit 2

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

Suggested Reading:

Mason, B (1986). Principles of Geochemistry. 3 rd Edition, Wiley New York.2. Rollinson H. (2007). Using geochemical data-evaluation. Presentation and interpretation. 2nd Edition. Publisher Longman Scientific & Technical.

Henderson, P., 1982. Inorganic Geochemistry, Pergamon Press, Oxford.

Unit 3

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

Suggested Reading:

Mason, B (1986). Principles of Geochemistry. 3 rd Edition, Wiley New York.2. Rollinson H. (2007). Using geochemical data-evaluation. Presentation and interpretation. 2nd Edition. Publisher Longman Scientific & Technical.

Krauskopf, K. B., 1979 Introduction to Geochemistry. McGraw Hill.

Unit 4

Concept of radiogenic isotopes in Geochronlogy.
Suggested Readings:
Faure, G., 1986. Principle of Isotope Geology, J. Wiley & Sons.

Practicals

Geochemical data analysis and interpretation of common geochemical plots.

References

1. Mason, B (1986). Principles of Geochemistry. 3 rd Edition, Wiley New York.2. Rollinson H. (2007). Using geochemical data-evaluation. Presentation and interpretation. 2nd Edition. Publisher Longman Scientific & Technical.

2. Walther John, V., 2009 Essentials of geochemistry, student edition. Jones and Bartlett Publishers

3. Albarede, F, 2003. An introduction to geochemistry. Cambridge University Press.

4. Dickin' A. P., 1995,Rdiogenic Isotope Geology, Cambridgy UniversityPress

5. Faure, G., 1986. Principle of Isotope Geology, J. Wiley & Sons.

6. Henderson, P., 1982. Inorganic Geochemistry, Pergamon Press, Oxford.

4. Krauskopf, K. B., 1979 Introduction to Geochemistry. McGraw Hill.

8. Mason, B. 1982 Principles of Isotope Geology, J. Willey &Sons.

9. Geochemistry by William M White, Wiley-Blackwell (2103).

Weekly Teaching plan

Week 1
Origin of chemical elements and stellar evolution.
Abundance of elements in cosmos, solar system and earth.
Practical: Exercises on periodic properties of elements w.r.t. earth's reservoirs.

Week 2
Origin of chemical elements and stellar evolution.
Abundance of elements in cosmos, solar system and earth.
Practical: Exercises on chemical variation of elements w.r.t earth's interior

Week 3
Meteorites, Distribution of elements in core, mantle, crust.
Practical: Geochemical data analysis

Week 4
Introduction to properties of elements:
Practical: Geochemical data analysis

Week 5
The periodic table Chemical bonding, states of matter and atomic environment of elements, Geochemical classification of elements

Practical: Geochemical data analysis

Week 6
Geochemistry of igneous rocks: geochemical variability of magma and its products.
Practical: Geochemical data analysis

Week 7
Geochemistry of igneous rocks: geochemical variability of magma and its products.
Practical: Exercise based on Interpretation of common geochemical plots.

Week 8
Near surface geochemical environment: Eh-pH diagram; Chemical weathering of minerals and rocks.
Practical: Exercise based on Interpretation of common geochemical plots.

Week 9
Near surface geochemical environment: Eh-pH diagram; Chemical weathering of minerals and rocks.

Week 9
Near surface geochemical environment: Eh-pH diagram; Chemical weathering of minerals and rocks.
Practical: Exercise based on Interpretation of common geochemical plots.

Week 10
Use of geochemical variation diagram
Practical: Exercise based on Interpretation of common geochemical plots.

Week 11
Trace element fractionation concept
Practical: Exercise based on Interpretation of common geochemical plots.

Week 12
Trace element fractionation concept w.r.t. understanding of geological processes
Practical: Exercise based on Interpretation of common geochemical plots.

Week 13
Concepts of isotopes: Stable and isotopic
Practical: Exercise based on Interpretation of common geochemical plots.

Week 14
Concept of radiogenic isotopes in Geochronology.
Practical: Exercise based on Interpretation of common geochemical plots.

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Crystal chemistry, geochemical differentiation, geochemical cycles, crustal abundances,

IGNEOUS PETROLOGY

(GEOL CC6)

Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective (2-3)

To develop an understanding of the types of magma as well as types of igneous rocks. Magma generation in relation to the geodynamic setting and its relation with the size and fabric of igneous rocks

Course Learning Outcomes

On completion of the course, the student should be able to:

a) Determine the evolution of igneous rocks using petrographical, mineralogical and geochemical indices

b) Describe magmatic rocks from a plate tectonic point of view.

Unit 1

Introduction to Igneous Petrology: Scope of Igneous petrology, classification of Igneous rocks, igneous textures, igneous structures.

Suggested Reading:

Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.

Unit 2

Introduction to silicate melts and magmas

Physical properties of magma, the ascent of magmas, magmatic differentiation.

Suggested Reading:

Sen, G. (2014) Petrology Principles and Practice, Springer-Verlag Berlin Heidelberg.

Unit 3

Introduction to Igneous Phase diagrams

The phase rule, the lever rule, Two Component systems involving melt: Binary system with a Eutectic, Binary system with a peritectic, Binary system thermal barrier, Binary system with solid solution, Binary system with partial solid solution.

Suggested Reading:

Frost, B. R. and Frost, C. D., (2013) Essentials of Igneous and Metamorphic Petrology Cambridge University Press

Unit 4

The chemistry of igneous rocks

Modal mineralogy, normative mineralogy, variation diagrams based on major elements, major element indices of differentiation, identification of differentiation processes using trace elements, application of radioactive isotopes in igneous petrology.

Suggested Reading:

Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.

Wilson, M. (1989) Igneous Petrogenesis, Springer-Verlag Berlin Heidelberg.

Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.

Unit 5

Introduction to igneous environments.

Basalts and mantle structure, Oceanic magmatism, Igneous Rocks of Convergent Margins and Igneous Rocks of the Continental Lithosphere.

Suggested Reading:

Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.

Practicals

Study of important igneous rocks in hand specimens and thin sections- granite, granodiorite, diorite, gabbro, anorthosites, ultramafic rocks, basalts, andesites, trachyte, rhyolite.
Calculation of Norm & Classification of Igneous Rocks.
Plotting and interpretation of variation diagrams.
Igneous rock occurrences in Indian context.

References

1. Frost, B. R. and Frost, C. D., (2013)Essentials of Igneous and Metamorphic Petrology Cambridge University Press.
2. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
3. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
4. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
5. Sen, G. (2014) Petrology Principles and Practice, Springer-Verlag Berlin Heidelberg
6. Bose M.K. (1997). Igneous Petrology.
7. Wilson, M. (1989) Igneous Petrogenesis, Springer-Verlag Berlin Heidelberg
8. Janoušek, V., Moyen, J.-F., Martin, H., Erban, V., Farrow, C. (2016) Geochemical Modelling of Igneous Processes – Principles and Recipes in R Language Bringing the

Weekly Teaching Plan

Week 1
Scope of Igneous petrology, classification of igneous rocks

Week 2
Igneous textures, igneous structures.

Week 3
Introduction to silicate melts and magmas, Physical properties of magma.

Week 4
The ascent of magmas, magmatic differentiation.

Week 5
Introduction to Igneous Phase diagrams, the phase rule, the lever rule,

Week 6
Two Component systems involving melt, Binary system with a Eutectic

Week 7
Binary system with a paratactic, Binary system thermal barrier

Week 8
Binary system with solid solution, Binary system with partial solid solution.

Week 9
The chemistry of igneous rocks, Modal mineralogy, normative mineralogy, variation diagrams Based on major elements

Week 10
Major element indices of differentiation, identification of differentiation processes using trace elements

Week 11
Application of radioactive isotopes in igneous petrology

Week 12
Introduction to igneous environments, Basalts and mantle structure

Week 13
Oceanic magmatism, Igneous Rocks of Convergent Margins

Week 14
Igneous Rocks of the Continental Lithosphere.

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Magma and lava, granite, basalt, batholith, large igneous province, plate tectonics

STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY

(GEOL CC7)

Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective (2-3)

To understand rock superposition through time and relative age of rocks.

To deciper the paleogeographic changes (distribution of land and sea) at broader scale and incremental shift of environment, energy conditions, tectonics, climate etc. at finer scale within basin or formation level.

Course Learning Outcomes

Comprehensive understanding of fundamentals of stratigraphic principles and various methods of stratigraphic analysis will be provided. The stratigraphic classification from craton, mobile belt, Proterozoic to Phanerozoic succession from India is the goal of this course. Time concept in stratigraphic and major stratigraphic boundaries and their causative factors will be discussed in detail. Geological factors controlling the hydrocarbon accumulation and their future prospective will be discussed.

Unit 1

Principle of stratigraphy: Definition and scope of stratigraphy, principle of superposition, original horizontality and uniformitarianism. Fundamentals of litho-, bio- and chrono-stratigraphy. Facies concept in stratigraphy, Walther's Law of facies succession. Concept of paleogeographic reconstruction. Introduction to concepts of dynamic stratigraphy (chemostratigraphy, seismic stratigraphy, sequence stratigraphy, magnetostratigraphy and their subdivisions with Indian examples.

Suggested Readings:
Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley.
Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.

Unit 2

Code of stratigraphic nomenclature: International Stratigraphic Code – development of a standardized stratigraphic nomenclature, Concept of Stratotypes. Global Stratotype Section and Point (GSSP).

Suggested Reading:
Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.

Unit 3

Precambrian Stratigraphy: Brief introduction to the physiographic and tectonic subdivisions of India. Introduction to Indian Shield (ctraton and mobile belts of India). Introduction to Proterozoic sedimentary basins of India. Geology of Vindhyan and Cudappah basins.

Suggested Reading:
Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi.

Unit 4

Phanerozoic Stratigraphy

Paleozoic stratigraphy of India:Palaeozoic Succession of Kashmir and its correlatives from Spiti and Zanskar Stratigraphy. Geology and hydrocarbon potential of Gondwana basins.

Mesozoic stratigraphy of India:Triassic successions of Spiti; Jurassic of Kutch; Cretaceous succession of Cauvery Basin

Cenozoic stratigraphy of India: Kutch basin; Siwalik succession; Assam, Andaman and Arakan basins; Stratigraphy and structure of Krishna-Godavari basin, Cauvery basin, Bombay offshore basin, Kutch and Saurashtra basins and their potential for hydrocarbons.

Suggested Readings:
Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological Society of India, Bangalore.
Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi.
Valdiya, K. S. (2010) The making of India, Macmillan India Pvt. Ltd.

Unit 5

Volcanic provinces of India: Deccan Traps; Rajmahal Traps; Sylhet Trap.

Suggested Readings:
Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological Society of India, Bangalore.
Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi.

Unit 6

Major stratigraphic boundaries: Precambrian-Cambrian boundary; Permian-Triassic boundary; Cretaceous-Palaeogene boundary.

Suggested Reading:
Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological Society of India, Bangalore.

Practicals

1. Study of geological map of India and identification of major stratigraphic units
2. Study of rocks in hand specimens from known Indian stratigraphic horizons
3. Drawing various palaeogeographic maps.
4. Study of different Proterozoic supercontinent reconstructions.
5. Interpretation of various stratigraphic logs and their correlation.

References

1. Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi
2. Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley
3. Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological society of India, Bangalore.
4. Valdiya, K. S. (2010). The making of India, Macmillan India Pvt. Ltd.
5. Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.

Teaching Plan

Week 1

Introduction to stratigraphy, stratigraphic principles, correlation, facies concept;

palaeogeographic reconstructions

Week 2
Stratigraphic units - litho-, bio-, chrono- magneto-stratigraphic units; Sequence stratigraphy, seismic stratigraphy, chemostratigraphy.

Week 3
International Code of Stratigraphic Nomenclature , Stratotypes, Global Stratotypes Section and Point (GSSP)

Week 4
Physiographic and tectonic subdivisions of India

Week 5
Introduction to craton and mobile belts of India

Week 6
Proterozoic sedimentary basins of India

Week 7
Stratigraphy of Vindhyan and Cuddapah basins

Week 8
Phanerozoic successions of Kashmir, Spiti and Zanskar basins.

Week 9
Gondwana basins of India and their economical potential

Week 10
Triassic sequence of Spiti, Jurassic stratigraphy of Kutch; Cretaceous succession of Cauvery Basin

Week 11
Palaeogene and Neogene strata of Kutch, Siwalik stratigraphy; Hydorcarbon potential of Assam, Andaman and Arakan.

Week 12
Hydrocarbon potential of K-G, Cauvery, Bombay offshore, and Kutch Saurashtra basins

Week 13
Deccan volcanics, Rajmahal and Sylhet volcanics

Week 14
Pc-C boundary, P-T boundary, K-Pg boundary

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Stratigraphic nomenclature, superposition, chronostratigraphy, lithostratigraphy, biostratigraphy, Phanerozoic.

METAMORPHIC PETROLOGY

(GEOL CC8)

Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective (2-3)

Learn to consider metamorphic rocks as chemical system as well as major variables affecting the system

To be able to appreciate the deduction of P-T from metamorphic mineral assemblages

To understand significance of mineral assemblages and fabric in relation to the geodynamic setting

Course Learning Outcomes

1. Understanding nature of metamorphic rocks in contrast to igneous and sedimentary rocks

2. Applying phase rule as a basic tools in study of these rocks and through learning control of bulk composition on assemblage development

3. Identifying equilibrium mineral assemblages through textural and mineralogical observations

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

5. Relate and understand mineral assemblages and texture for tectonic and geodynamic interpretations especially in mountain building.

Unit 1

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

Suggested Reading:

Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Earth Science Series.

Unit 2

Chemographic projections, concept of compatible and incompatible assemblages and discontinuous reactions, bulk composition influence on metamorphic assemblages

Structure and textures of metamorphic rocks, Relationship between metamorphism and deformation.

Suggested Reading:

Winter, J. D. (2014).Principles of igneous and metamorphic petrology. Pearson.

Unit 3

Metamorphic zones and isograde.

Metamorphic mineral reactions (prograde and retrograde)- exchange vectors and continuous reactions, Metamorphism series- Low P, Intermediate P and high P series

Suggested Reading:

Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology, Longman Earth Science Series.

Unit 4

Concept of metamorphic facies and grade, Migmatites and their origin

Metasomatism and role of fluids in metamorphism , basics of geothermobarometry.

Suggested Reading:
Winter, J. D. (2014).Principles of igneous and metamorphic petrology, Pearson.

Unit 5
Metamorphic rock associations-schists, gneisses, khondalites, charnockites, blueschists and eclogites, tectonic setting of metamorphic rocks, paired metamorphic belts.
Suggested Reading:
Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Earth Science Series.

References
1. Philpotts, A., & Ague, J. (2009).Principles of igneous and metamorphic petrology . Cambridge University Press.
2. Winter, J. D. (2014).Principles of igneous and metamorphic petrology, Pearson.
3. Raymond, L.A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
4. Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology, Longman Earth Science Series.

Weekly Teaching Plan

Week 1
Metamorphism: Phase rule and Goldschmidt mineralogical phase rule, pure and impure phases.

Week 2
Definition of metamorphism. Factors controlling metamorphism,

Week 3
Types of metamorphism.

Week 4
Chemographic projections

Week 5
Concept of compatible and incompatible assemblages

Week 6
Bulk composition influence on metamorphic assemblages

Week 7
Structure and textures of metamorphic rocks, Relationship between metamorphism and deformation.

Week 8
Metamorphic zones and isograde**s**. Metamorphism series- Low P, Intermediate P and high P series.

Week 9
Metamorphic mineral reactions (prograde and retrograde).

Week 10
Exchange vectors and continuous reactions

Week 11
Concept of metamorphic facies and grade

Week 12
Migmatites and their origin

Week 13
Metasomatism and role of fluids in metamorphism

Week 14
Metamorphic rock associations-schists, gneisses, khondalites, charnockites, blueschists and eclogites, tectonic setting of metamorphic rocks, paired metamorphic belts.

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Mineral assemblages, facies, phase rule, continuous and discontinuous reactions, metamorphic facies

PALAEONTOLOGY

(GEOL CC9)
Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective (2-3)

To learn about the life forms of the geological past.

To understand the diversity and evolution of past life.

To know the evolutionary transitions and functional adaptations in different groups of animals and plants.

Course Learning Outcomes

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

- Appreciate how fossils get preserved in rocks, the nature of fossil record and how fossils are named in a taxonomic framework
- Get to know different invertebrate fossil groups, their palaeobiology, and how they can be used in relative dating of rocks.
- Learn how vertebrates originated and their evolution through time.
- Understand important floral changes over time and the flora of the Indian coal-bearing sedimentary basins.
- Analyse the indirect evidences preserved in the rocks for the past existence of life.
- Critically analyse the role of fossils in relative dating of rocks, in interpreting past environments, past distribution of land and sea, and changes in ecosystems over time.

Unit 1

Fossilization and fossil record; Fossilization processes and modes of preservation; nature and importance of fossil record

Taxonomy and Species concept**;** Species concept with special reference to palaeontology, taxonomic hierarchy, Theory of organic evolution interpreted from fossil record.

Suggested Readings:
Raup, D. M. & Stanley, S.M. (1985). Principles of Paleontology, W.H.Freeman & Company
Clarkson, E. N.K. (2012) Invertebrate Paleontology and evolution 4th Edition by Blackwell Publishing.
Foote, M. & Miller, A. I. (2006). Principles of Paleontology, third edition.

Unit 2

Brief introduction to important invertebrate groups (Bivalvia, Gastropoda, Brachiopoda, Graptolites, Trilobites) and their biostratigraphic significance

Significance of ammonites in Mesozoic biostratigraphy and their palaeobiogeographic implications

Functional adaptation in trilobites and ammonoids.

Suggested Reading:
Clarkson, E. N.K. (2012) Invertebrate Paleontology and evolution 4th Edition by Blackwell Publishing.

Unit 3

Vertebrates: Origin of vertebrates and major steps in vertebrate evolution; Vertebrate evolution in the Palaeozoic Era; Mesozoic reptiles with special reference to origin diversity and extinction of dinosaurs

Vertebrate Transitions

Evolution of horse and intercontinental migrations; Human evolution.

Suggested Reading:
Benton, M. (2014). Vertebrate Palaeontology, fourth edition.

Unit 4

Introduction to Palaeobotany; fossil record of plants through time; Gondwana Flora.

Suggested Reading:
Shukla, A. C. & Mishra, S.P. (1982).Essentials of Palaeobotany.

Unit 5

Introduction to Ichnology; utility of ichnofossils in interpreting sedimentary environments.

Application of fossils in Stratigraphy; Biozones, index fossils, correlation; Role of fossils in sequence stratigraphy; Fossils and palaeoenvironmental analysis; Fossils and paleobiogeography, biogeographic provinces, dispersals and barriers; Paleoecology – fossils as a window to the evolution of ecosystems.

Suggested Readings:
Clarkson, E. N.K. (2012) Invertebrate Paleontology and evolution 4th
Edition by Blackwell Publishing.
Benton, M.J. & Harper, D.A.T. (2016). Introduction to Palaeobiology and the fossil record. Wiley

Jones, R.W. (2011). Applications of Palaeontology - Techniques and Case Studies

Practicals

Study of fossils showing various modes of preservation.

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

References

1. Raup, D. M., Stanley, S.M., Freeman, W. H. (1971). Principles of Paleontology
2. Clarkson, E. N.K.(2012)Invertebrate Paleontology and evolution 4th Edition by Blackwell Publishing.
3. Benton, M. (2014). Vertebrate Palaeontology, fourth edition
4. Shukla, A. C., & Misra, S.P. (1982).Essentials of Palaeobotany.
5. Stewart, W.N. & Rothwell, G.W. (2018). Palaeobotany and the Evolution of Plants
6. Armstrong, H.A., & Brasier, M.D. (2005) Microfossils. Blackwell Publishing.
7. Jones, R.W. (2011). Applications of Palaeontology - Techniques and Case Studies
8. Briggs, D.E.G. & Crowther, P.R. (2003). Palaeobiology II.
9. Foote, M. & Miller, A. I. (2006). Principles of Paleontology, third edition.

Teaching Plan

Week 1

Fossilization and fossil record, fossilization processes and modes of preservation; Nature and importance of fossil record.

Week 2

Taxonomy and Species concept; Species concept with special reference to palaeontology, taxonomic hierarchy,

Week 3

Theory of organic evolution interpreted from fossil record.

Week 4

Brief introduction to important invertebrate groups (Bivalvia, Gastropoda, Brachiopoda) and their biostratigraphic significance.

Week 5

Functional adaptation in trilobites and ammonoids.

Week 6

Significance of ammonites in Mesozoic biostratigraphy and their palaeobiogeographic implications.

Week 7

Functional adaptation in trilobites and ammonoids.

Week 8

Origin of vertebrates and major steps in vertebrate evolution; Vertebrate evolution in the Palaeozoic Era.

Week 9

Mesozoic reptiles with special reference to origin diversity and extinction of dinosaurs; Evolution of horse and intercontinental migrations; Vertebrate transitions

Week 10

Human evolution; Introduction to Palaeobotany; fossil record of plants through time; Gondwana Flora

Week 11

Introduction to Ichnology; utility of ichnofossils in interpreting sedimentary environments.

Week 12

Application of fossils in Stratigraphy; Biozones, index fossils, correlation; Role of fossils in sequence stratigraphy

Week 13

Fossils and paleobiogeography, biogeographic provinces, dispersals and barriers

Week 14

Fossils and palaeoenvironmental analysis; Paleoecology– fossils as a window to the evolution of ecosystems.

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Fossils, vertebrates, invertebrates, palaeobotany, palaeobiology

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GEOMORPHOLOGY

(GEOL CC10)- (CC)
Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective (2-3)
The main aim of this course is to 1) learn about the fundamentals of Geomorphology, 2) learn

Course Learning Outcomes
In this course a student will learn about 1) the advantages to study geomorphology, 2) fundamentals of working of earth surface processes, and 3) various geomorphic techniques, 4) geomorphology of India, and 5) extra-terrestrial landforms.

Unit 1

Introduction to Geomorphology: Geosphere-Hydrosphere-Biosphere; unifying concepts

Suggested Reading:
M.A. Summerfield (1991) Global Geomorphology. Wiley & Sons.

Unit 2
Geoid, Topography, Hypsometry, Global Hypsometry, Major Morphological features

Large Scale Topography - Ocean basins, Plate tectonics overview, Large scale mountain ranges (with emphasis on Himalaya)

Suggested reading:
Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.

Unit 3
Surficial Processes and geomorphology; Weathering and associated landforms, Hill slopes Glacial, Periglacial processes and landforms, Fluvial processes and landforms, Aeolian Processes and landforms, Coastal Processes and landforms, Landforms associated with igneous activities

Suggested Readings:
Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.
Paul R. Bierman and D.R. Montgomery (2014): Key Concepts in Geomorphology. W.H. Freeman and Company Publishers.

Unit 4

Dating Methods, measuring rates; Rates of uplift and denudation, Tectonics and drainage development, Sea-level change, Long-term landscape development

Suggested Readings:
Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.
Paul R. Bierman and D.R. Montgomery (2014): Key Concepts in Geomorphology. W.H. Freeman and Company Publishers.

Unit 5

Overview of Indian Geomorphology; Introduction to Extra-terrestrial landforms

Suggested Reading:
M.A. Summerfield (1991) Global Geomorphology. Wiley & Sons.

Practicals

- Reading topographic maps
- Concept of scale
- Preparation of a topographic profile
- Preparation of longitudinal profile of a river
- Preparing Hack Profile and Calculating Stream length gradient index
- Morphometry of a drainage basin - Calculating different morphometric parameters

- Preparation of geomorphic map

References

1. Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.
2. Paul R. Bierman and D.R. Montgomery (2014): Key Concepts in Geomorphology. W.H. Freeman and Company Publishers.
3. M.A. Summerfield (1991) Global Geomorphology. Wiley & Sons.

Weekly Teaching Plan

Week 1
Introduction to Geomorphology; Geosphere-Hydrosphere-Biosphere

Week 2
Unifying concepts

Week 3
Geoid, Topography, Hypsometry, Global Hypsometry, Major Morphological features

Week 4
Large Scale Topography - Ocean basins, Plate tectonics overview

Week 5
Large scale mountain ranges (with emphasis on Himalaya); Surficial Processes and geomorphology,

Week 6
Weathering and associated landforms, Hill slopes

Week 7
Glacial, Periglacial processes and landforms,

Week 8
Fluvial processes and landforms,

Week 9
Aeolian Processes and landforms, Coastal Processes and landforms

Week 10
Landforms associated with igneous activities; Dating Methods

Week 11
Measuring rates; Rates of uplift and denudation,

Week 12
Tectonics and drainage development, Sea-level change, Long-term landscape development

Week 13
Overview of Indian Geomorphology

Week 14
Introduction to Extra-terrestrial landforms

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Landforms, tectonics. Geoid, Surface processes

ECONOMIC GEOLOGY

(GEOL CC11)
Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective (2-3)

To introduce and acquaint the student to the natural occurrences of economic mineral deposits linking theory of mineral deposit formation to field-based interpretations

Course Learning Outcomes

Demonstration of field occurrence of mineral deposits- over ground as well as underground.
Identification and recording of evidence of mineralization such as alteration zones etc.
Learning the role of geology in mining of the mineral deposits.

Unit 1
Ores and gangues
Ores, gangue minerals, tenor, grade and lodes
Resources and reserves-Economic and Academic definitions
Metallic, industrial and strategic minerals

Suggested Reading:
Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.

Unit 2
Mineral deposits and classical concepts of ore formation
Mineral occurrence, Mineral deposit and Ore deposit
Historical concepts of ore genesis: Man's earliest vocation-Mining
Plutonist and Neptunist concepts of ore genesis

Suggested Reading:
Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.

Unit 3
Mineral economics
Methods of economic evaluation of resources and reserves, characterization curve, order of magnitude and other economic evaluations, pre-feasibility and feasibility studies, cash flow, mineral conservation, United Nations Framework classification (UNFC), National mineral policy.

Suggested Reading:
Chatterjee, K. K.: An Introduction to Mineral Economics

Unit 4
Structure and texture of ore deposits
Concordant and discordant ore bodies
Endogenous processes: Magmatic concentration, skarns, greisens, and hydrothermal deposits
Exogenous processes: weathering products and residual deposits, oxidation and supergene
Enrichment, placer deposits.

Suggested Reading:
Laurence Robb. (2005) Introduction to ore forming processes. Wiley.

Unit 5
Ore grade and Reserve, assessment of grade, reserve estimation

Suggested Reading:
Sinha, R K. and Sharma. N. L.: Mineral Economics

Unit 6
Distribution of ores and minerals
Metallogenic provinces and epochs
Important deposits of India including atomic minerals Non-metallic and industrial rocks and minerals, in India.
Introduction to gemstones.

Suggested Reading:
Gokhale, K.V.G.K.and Rao, T.C. (1978) Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.

Weekly Teaching Plan

Week 1
Ores, gangue minerals, tenor, grade and lodes

Week 2
Resources and reserves-Economic – definitions; Metallic, industrial and strategic minerals

Week 3
Mineral occurrence, Mineral deposit and Ore deposit

Week 4
Historical concepts of ore genesis

Week 5
Plutonist and Neptunist concepts of ore genesis

Week 6
Methods of economic evaluation of resources and reserves,

Week 7
Characterization curve, order of magnitude and other economic evaluations, pre-feasibility and feasibility studies, cash flow.

Week 8

United Nations Framework classification (UNFC) National mineral policy and mineral conservation.

Week 9
Endogenous processes: Magmatic concentration, skarns, greisens, and hydrothermal deposits

Week 10
Exogenous processes: weathering products and residual deposits, oxidation and supergene enrichment, placer deposits

Week 11
Ore grade and Reserve, assessment of grade, reserve estimation

Week 12
Important deposits of India including atomic minerals

Week 13
Non-metallic and industrial rocks and minerals, in India.

Week 14
Introduction to gemstones.

Teaching Learning Process
Demonstration and measurements

Assessment Methods
Field report and viva-voce

Keywords
Mineral deposit, ore, gangue, mine, exploration, beneficiation, smelting

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REMOTE SENSING AND GIS

(GEOL CC12)

Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective (2-3)

The main aim of this course is to 1) learn about the fundamentals of remote sensing, photogeology, GIS, and GPS, 2) learn basics remote sensing and GIS techniques, and 3) learn use of remote sensing and GIS in different fields.

Course Learning Outcomes

In this course a student will learn about 1) the basic concepts of remote sensing, 2) Basic concepts of Photogeology and Photogrammetry, 3) the basic concepts of GIS, 4) GIS softwares viz., QGIS, Basic concepts and functioning of Global Positioning System (GPS).

Unit 1

Photogeology: Types and acquisition of aerial photographs; Scale and resolution; Principles of Stereoscopy, relief displacement, vertical exaggeration and distortion, Elements of aerial photo interpretation, Identification of sedimentary, igneous and metamorphic rocks.

Suggested Reading:
Bhatta, B. Remote Sensing and GIS. Oxford Publications.

Unit 2
Remote Sensing
History of Remote Sensing and Indian Space Program, Basic concepts of Remote Sensing, Satellites and their characteristics, Data formats- Raster and Vector.
*Suggested Readin*g:
Bhatta, B. Remote Sensing and GIS. Oxford Publications.
Lillesand, Kiefer and Chipman. Remote Sensing and Image Interpretation. Wiley Publications

Unit 3
Digital Image Processing
Various processes of Digital Image Processing – Pre-processing, Image Enhancement, Transformation. Filtering, Image Rationing, Image classification, and accuracy assessment (Errors calculation).

Suggested Reading:
Bhatta, B. Remote Sensing and GIS. Oxford Publications.
Lillesand, Kiefer and Chipman. Remote Sensing and Image Interpretation. Wiley Publications

Unit 4
GIS: Datum, Coordinate systems and Projection systems, spatial data models and data editing, Introduction to DEM analysis, GIS integration and Case studies-Indian Examples.
Suggested Reading:
PA Longley, MF Goodchild, DJ Maguire and DW Rhind. Geographic Information System and Science. Wiley Publications
MN Demers. Fundamentals of Geographic Information Systems. Wiley Publications.

Unit 5
GPS: Basic concepts of GPS, Integrating GPS data with GIS Applications in earth system Sciences.
Suggested Reading:
Bhatta, B. Remote Sensing and GIS. Oxford Publications.

Practicals
- Aerial Photo interpretation, identification landforms
- Digital Image Processing exercises including analysis of satellite data in different bands and interpretation of various objects on the basis of their spectral signatures.
- Creating a FCC from raw data
- Geo-referencing of satellite data with a toposheet of the area
- Introduction to QGIS software
- DEM analysis: generating slope map, aspect map and drainage network map

References
Bhatta, B. Remote Sensing and GIS. Oxford Publications.
Lillesand, Kiefer and Chipman. Remote Sensing and Image Interpretation. Wiley Publications
PA Longley, MF Goodchild, DJ Maguire and DW Rhind. Geographic Information System and Science. Wiley Publications
MN Demers. Fundamentals of Geographic Information Systems. Wiley Publications.

Weekly Teaching Plan

Week 1
Photogeology; Types and acquisition of aerial photographs; Scale and resolution;

Week 2
Principles of stereoscopy, relief displacement, vertical exaggeration and distortion, Elements of aerial photo interpretation

Week 3
Identification of sedimentary, igneous and metamorphic rocks

Week 4
History of Remote Sensing and Indian Space Program

Week 5
Basic concepts of Remote Sensing, Satellites and their characteristics, Data formats- Raster and Vector

Week 6
Various processes of Digital Image Processing – Pre-processing

Week 7
Image Enhancement, Transformation

Week 8
Filtering, Image Rationing

Week 9
Image classification, and accuracy assessment (Errors calculation).

Week 10
Datum, Coordinate systems and Projection systems,

Week 11
Spatial data models and data editing,

Week 12
Introduction to DEM analysis, GIS integration

Week 13
Basic concepts of GPS

Week 14
Integrating GPS data with GIS Applications in earth system sciences

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
GIS, GPS, Photogeology, Digital Image Processing, DEM

ENGINEERING GEOLOGY

(GEOL CC13)

Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective (2-3)

Develop an understanding of significance of geology in major engineering projects.

Necessity of geological input in designing of dams, tunnels, roads etc.

Course Learning Outcomes

1. Significance of geology in major engineering projects
2. Method of assessing geological perspective of major infrastructure projects
3. Rock properties related to the strength and bearing capacities of rocks and soils
4. Learning major techniques for ameliorating engineering properties of earth material
5. Understanding the effect and relationship of natural hazards on engineering projects

Unit 1

Geology vs. Engineering, Role of Engineering geologists in planning, design and construction of major man-made structural features.

Suggested Reading:

Krynin, D.P.and Judd, W.R. (1957). Principles of Engineering Geology and Geotechnique, McGraw Hill (CBS Publ).

Johnson, R.B. and De Graf,J.V. (1988). Principles of Engineering Geology, John Wiley.

Unit 2

Site investigation and characterization

Suggested Reading:

Johnson, R.B. and De Graf,J.V. (1988). Principles of Engineering Geology, John Wiley.

Goodman, R.E. (1993). Engineering Geology:Rock in Engineering constructions. John Wiley & Sons, N.Y.

Unit 3

Foundation treatment; Grouting, Rock Bolting and other support mechanisms

Suggested Reading:

Johnson, R.B. and De Graf, J.V. (1988). Principles of Engineering Geology, John Wiley.

Goodman, R.E. (1993). Engineering Geology:Rock in Engineering constructions. John Wiley & Sons, N.Y.

Waltham, T. (2009). Foundations of Engineering Geology(3rd Edn.)Taylor & Francis.

Unit 4

Intact Rock and Rock Mass properties

Rock aggregates; Significance as Construction Material

Suggested Reading:

Goodman, R.E. (1993). Engineering Geology: Rock in Engineering constructions. John Wiley & Sons, N.Y.
Waltham, T. (2009). Foundations of Engineering Geology (3rd Edn.)Taylor & Francis.

Unit 5
Concept, Mechanism and Significance of Rock Quality Designation (RQD) Concept, Mechanism and Significance of:
a. Rock Structure Rating (RSR)
b. Rock Mass Rating (RMR)
c. Tunnelling Quality Index (Q)
Geological, Geotechnical and Environmental considerations for Dams and Reservoirs
Suggested Reading:
Waltham, T. (2009). Foundations of Engineering Geology (3rd Edn.)Taylor & Francis.
Bell, F.G. (2006).Basic Environmental and Engineering Geology Whittles Publishing

Unit 6
Tunnels and Tunnelling Methods
Suggested Reading:
Waltham, T. (2009). Foundations of Engineering Geology (3rd Edn.)Taylor & Francis.

Practicals

1. Computation of reservoir area, catchment area, reservoir capacity and reservoir life.
2. Merits, demerits & remedial measures based upon geological cross sections of project sites.
3. Computation of Index properties of rocks.
4. Computation of RQD, RSR, RMR and 'Q

References

1. Krynin, D.P.and Judd, W.R. (1957). Principles of Engineering Geology and Geotechnique, McGraw Hill (CBS Publ).
2. Johnson, R.B. and De Graf, J.V. (1988). Principles of Engineering Geology, John Wiley.
3. Goodman, R.E. (1993). Engineering Geology: Rock in engineering constructions. John Wiley& Sons, N.Y.
4. Waltham, T. (2009). Foundations of Engineering Geology (3rd Edn.)Taylor & Francis.
5. Bell, F.G. (2006).Basic Environmental and Engineering Geology Whittles Publishing.
6. Bell, F.G (2007).Engineering Geology, Butterworth-Heinema.

Weekly Teaching plan

Week 1
Geology vs. Engineering

Week 2

Role of engineering geologists in planning, design and construction of major man-made structural features.

Week 3
Site investigation and characterization

Week 4
Foundation treatment; Grouting

Week 5
Rock Bolting and other support mechanisms

Week 6
Intact Rock and Rock Mass properties

Week 7
Rock aggregates; Significance as Construction Material

Week 8
Concept, Mechanism and Significance of Rock Quality Designation (RQD) Concept, Mechanism and Significance of Rock Structure Rating (RSR)

Week 9
Rock Mass Rating (RMR)
Tunnelling Quality Index (Q)
Geological, Geotechnical and Environmental considerations for Dams and Reservoirs

Week 10
Geological, Geotechnical and Environmental considerations for Dams and Reservoirs

Week 11
Geological, Geotechnical and Environmental considerations for Dams and Reservoirs

Week 12
Tunnels and Tunnelling Methods

Week 13
Tunnels and Tunnelling Methods

Week 14
Engineering projects in geological and societal perspective

Teaching Learning Process
Lectures, Practical's, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations

Keywords

Regional and detailed mapping, Rock mass rating and rock quality designation, foundation, grouting.

HYDROGEOLOGY

(GEOL CC14)

Core Course – (CC) Credit: Theory (4) Practical (2)

Course Objective

To understand about the nature, occurrence and movement of groundwater in geological context.

To develop basic understanding about ground water exploration and management.

Learning outcome

The course will introduce students to the fundamental concepts of hydrogeology. They will learn about occurrence and movement of groundwater, aquifers and their parameters, groundwater exploration methods, aspects of groundwater chemistry and groundwater management.

Unit 1

Introduction and basic concepts: 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 subsurface water; Types of aquifer, aquifer parameters, anisotropy and heterogeneity of aquifers.

Suggested Reading:

Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.

Unit 2:

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

Suggested Reading:

Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.

Unit 3

Well hydraulics and Groundwater exploration: Basic Concepts of well hydraulics (drawdown; specific capacity etc.); Elementary concepts related to eequilibrium and non-equilibrium conditions for water flow to a well in confined and unconfined aquifers; Surface-based groundwater exploration methods.

Suggested Readings:

Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
Karanth, K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.
Raghunath, H.M. 2007. Groundwater, Third Edition, New Age International Publishers.

Unit 4

Groundwater chemistry: 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.
Karanth, K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co.

Unit 5:

Groundwater management: Basic concepts of water balance studies, issues related to groundwater resources development and management; Groundwater level fluctuations; Rainwater harvesting and artificial recharge of groundwater.

Suggested Readings:
Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
Karanth, K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co.

Practicals:

Preparation and interpretation of water level contour maps and depth to water level maps, preparation and analysis of hydrographs for differing groundwater conditions.

Graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams) Simple numerical problems related to: determination of permeability in field and laboratory, Groundwater flow, Well hydraulics etc.

Suggested Readings:

1. Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
2. Karanth, K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.

Additional Resources:

1. Davis, S. N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.
2. Raghunath, H.M. 2007. Groundwater, Third Edition, New Age International Publishers.
3. Shekhar Shashank, 2017a. Aquifer Properties. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: https://epgp.inflibnet.ac.in/ahl.php?csrno=448
4. Shekhar Shashank, 2017b. Darcy's law. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: https://epgp.inflibnet.ac.in/ahl.php?csrno=448
5. Shekhar Shashank. 2017c. Assessment of groundwater quality. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: https://epgp.inflibnet.ac.in/ahl.php?csrno=448
6. Syed Tajdarul Hassan, 2017a. Introduction to Hydrology. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: https://epgp.inflibnet.ac.in/ahl.php?csrno=448
7. Syed Tajdarul Hassan. 2017b. Hydraulic Head, Fluid Potential, Reynolds number and Pumping Tests-I. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: https://epgp.inflibnet.ac.in/ahl.php?csrno=448
8. Syed Tajdarul Hassan, 2017c. Hydraulic Head, Fluid Potential, Reynolds number and Pumping Tests-II. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: https://epgp.inflibnet.ac.in/ahl.php?csrno=448

Weekly Teaching plan

Week 1

Scope of hydrogeology and its societal relevance, Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration and subsurface movement of water.

Practical: Basic exercise based on depth to water level maps.

Week 2

Rock properties affecting groundwater, Vertical distribution of subsurface water.

Practical: Exercise based on depth to water level map.

Week 3

Types of aquifer and introduction to aquifer parameters.

Project/assignment based presentation by the students, evaluation and discussions on the same.

Practical: Basic exercise based on water table contour map.

Week 4

Detailed discussions on the aquifer parameters, anisotropy and heterogeneity of aquifers.

Project/assignment based presentation by the students, evaluation and discussions on the same.

Class Test/quiz - 1

Practical: Exercise based on water table contour map.

Week 5

Darcy's law and its validity, intrinsic permeability and hydraulic conductivity.

Project/assignment based presentation by the students, evaluation and discussions on the same.

Practical: Exercise based on water table contour map.

Week 6

Groundwater flow rates and flow direction, Laminar and turbulent groundwater flow.

Project/assignment based presentation by the students, evaluation and discussions on the same.

Practical: Exercise based on water table contour map.

Week 7

Basic Concepts of well hydraulics (drawdown; specific capacity etc.)

Project/assignment based presentation by the students, evaluation and discussions on the same.

Practical: Exercise based on water table contour map.

Week 8

Elementary concepts related to eequilibrium and non-equilibrium conditions for water flow to a well in confined and unconfined aquifers.

Project/assignment based presentation by the students, evaluation and discussions on the same.

Class Test/quiz - 2

Practical: Practical exercise based on preparation and analysis of hydrographs for differing groundwater conditions.

Week 9

Surface-based groundwater exploration methods

Project/assignment based presentation by the students, evaluation and discussions on the same.

Practical: Practical exercise based on preparation and analysis of hydrographs for differing groundwater conditions.

Week 10

Physical and chemical properties of water and water quality and Introduction to methods of interpreting groundwater quality data using standard graphical plots.

Project/assignment based presentation by the students, evaluation and discussions on the same.
Practical: Practical exercise based on graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams).

Week 11

Discussions on the standard graphical plots for interpreting groundwater quality continued and Sea water intrusion in coastal aquifers.

Project/assignment based presentation by the students, evaluation and discussions on the same

Practical: Practical exercise based on graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams).

Week 12
Basic concepts of water balance studies, issues related to groundwater resources development and management.
Project/assignment based presentation by the students, evaluation and discussions on the same.

Class Test/quiz - 3

Practical: Practical exercise based on graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams).

Week 13

Groundwater level fluctuations.

Project/assignment based presentation by the students, evaluation and discussions on the same.

Practical: Practical exercise based on graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams).

Week 14

Rainwater harvesting and artificial recharge of groundwater.

Project/assignment based presentation by the students, evaluation and discussions on the same.

Practical: Simple numerical problems related to: determination of permeability in field and laboratory, Groundwater flow, Well hydraulics etc.

Class Test/quiz - 4

Teaching Learning Process

Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods

Tests, Quiz, Debates, Project assignment and Presentations.

Keywords

Hydrogeology; aquifer parameters; Darcy's law; well hydraulics; groundwater exploration; groundwater quality; sea water intrusion; water balance.

EXPLORATION GEOLOGY

(GEOLDSE1)
Discipline Specific Elective – (DSE)
Credits: Theory (4), Practical (2)

Course Objective (2-3)

Exploration geology is concerned with the location of ore and other materials found within the Earth. Their work is essential to energy and production industries as it acts as a starting point for extraction.

Course Learning Outcomes

1. Understanding of industrial and non-industrial resources and distinction between reserve and resource
2. Natural resource consumption patterns through historical times
3. Principles of prospecting of exploration
3. Techniques of mineral exploration
4. Reserve estimation methods

Unit 1

Mineral Resources: Resource reserve definitions, Industrial and non-industrial economic Minerals; Mineral resources in industries – historical perspective and present; A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies.

Suggested Readings:
Arogyaswami, R.P.N. (1996). Courses in Mining Geology. 4th Ed. Oxford-IBH.
Moon, C.J., Whateley, M.K.G. & Evans, A.M. (2006), Introduction to Mineral Exploration, Blackwell Publishing.

Unit 2

Prospecting and Exploration: Principles of mineral exploration, Prospecting and exploration-conceptualization, methodology and stages, Sampling, subsurface sampling including pitting, trenching and drilling, geochemical exploration.

Suggested Readings:
Arogyaswami, R.P.N. (1996). Courses in Mining Geology. 4th Ed. Oxford-IBH.
Moon, C.J., Whateley, M.K.G. & Evans, A.M. (2006), Introduction to Mineral Exploration, Blackwell Publishing.

Unit 3

Geophysical methods of exploration

Evaluation of data; Evaluation of sampling data; Mean, mode, median, standard deviation and variance.

Suggested Readings:
Arogyaswami, R.P.N. (1996). Courses in Mining Geology. 4th Ed. Oxford-IBH.
Moon, C.J., Whateley, M.K.G. & Evans, A.M. (2006), Introduction to Mineral Exploration, Blackwell Publishing.

Unit 4

Drilling and Logging: Core and non-core drilling. Basic parts of a drilling machine; Planning of bore holes and location of boreholes on ground; Core-logging.

Suggested Readings:
Arogyaswami, R.P.N. (1996). Courses in Mining Geology. 4th Ed. Oxford-IBH.
Moon, C.J., Whateley, M.K.G. & Evans, A.M. (2006), Introduction to Mineral Exploration, Blackwell Publishing.
Clark, G.B. (1967). Elements of Mining. 3rd Ed. John Wiley & Sons.

Unit 5

Reserve estimations and Errors; Density and bulk density; Principles of reserve estimation, Critical Geological data to be considered Factors affecting reliability of reserve estimation; Reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks) Regular and irregular grid patterns, statistics and error estimation.

Suggested Readings:
Arogyaswami, R.P.N. (1996). Courses in Mining Geology. 4th Ed. Oxford-IBH.
Moon, C.J., Whateley, M.K.G. & Evans, A.M. (2006), Introduction to Mineral Exploration, Blackwell Publishing.
Clark, G.B. (1967). Elements of Mining. 3rd Ed. John Wiley & Sons.

Practicals

1. Identification of anomaly
2. Concept of weighted average in anomaly detection
3. Geological cross-section
4. Models of reserve estimation

References

1. Clark, G.B. (1967). Elements of Mining. 3rd Ed. John Wiley & Sons.
2. Arogyaswami, R.P.N. (1996). Courses in Mining Geology. 4th Ed. Oxford-IBH.
3. Moon, C.J., Whateley, M.K.G. & Evans, A.M. (2006), Introduction to Mineral Exploration, Blackwell Publishing.

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Reserve, resource, drilling, reserve estimation, exploration

EARTH AND CLIMATE

(GEOLDSE2)
Discipline Specific Elective – (DSE)
Credits: Theory (4), Practical (2)

Unit 1

Climate system: Forcing and Responses

Components of the climate system

Climate forcing, Climate controlling factors

Climate system response, response rates and interactions within the climate system Feedbacks

in climate system

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.

Unit 2

Heat budget of Earth

Incoming solar radiation, receipt and storage of heat

Heat transformation

Earth’s heat budget. Interactions amongst various sources of earth’s heat

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.
Lutgens, F., Tarbuck, E., and Tasa, D. (2009). The Atmosphere: An Introduction to Meteorology. Pearson Publisher.
Aguado, E., and Burt, J. (2009). Understanding Weather.

Unit 3

Atmosphere - Hydrosphere

Layering of atmosphere and atmospheric Circulation Atmosphere and ocean interaction and its effect on climate Heat transfer in ocean

Global oceanic conveyor belt and its control on earth's climate

Surface and deep circulation

Sea ice and glacial ice

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.
Lutgens, F., Tarbuck, E., and Tasa, D. (2009). The Atmosphere: An Introduction to Meteorology. Pearson Publisher.
Aguado, E., and Burt, J. (2009). Understanding Weather.

Unit 4

Response of biosphere to Earth's climate Climate Change: natural vs. anthropogenic effects Humans and climate change

Future perspectives

Brief introduction to archives of climate change

Archive based climate change data from the Indian continent

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.
Lutgens, F., Tarbuck, E., and Tasa, D. (2009). The Atmosphere: An Introduction to Meteorology. Pearson Publisher.
Aguado, E., and Burt, J. (2009). Understanding Weather.

Unit 5

Orbital cyclicity and climate

Milankovitch cycles and variability in the climate

Glacial-interglacial stages

The Last Glacial maximum (LGM) Pleistocene Glacial-Interglacial cycles Younger Dryas

Marine isotope stages

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.
Lutgens, F., Tarbuck, E., and Tasa, D. (2009). The Atmosphere: An Introduction to Meteorology. Pearson Publisher.
Aguado, E., and Burt, J. (2009). Understanding Weather.

Unit 6

Monsoon Mechanism of monsoon Monsoonal variation through time

Factors associated with monsoonal intensity

Effects of monsoon
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.
Lutgens, F., Tarbuck, E., and Tasa, D.(2009). The Atmosphere: An Introduction to Meteorology. Pearson Publisher.
Aguado, E., and Burt, J. (2009). Understanding Weather.

Practicals

1. Study of distribution of major climatic regimes of India on map
2. Distribution of major wind patterns on World map
3. Preparation of palaeogeographic maps (distribution of land and sea) of India during specific geological time intervals
4. Numerical exercises on interpretation of proxy records for paleoclimate

References

1. Rudiman, W.F. (2001). Earth's climate: past and future. Edition 2, Freeman Publisher.
2. Rohli, R.V., and Vega, A.J. (2007). Climatology. Jones and Barlatt.
3. Lutgens, F., Tarbuck, E., and Tasa, D. (2009). The Atmosphere: An Introduction to Meteorology. Pearson Publisher.
4. Aguado, E., and Burt, J. (2009). Understanding Weather.

Weekly Teaching Plan

Week 1
Climate system: Forcing and Responses. Components of the climate system. Climate forcing, Climate controlling factors.

Week 2
Climate system response, response rates and interactions within the climate system. Feedbacks in climate system.

Week 3
Heat budget of Earth Incoming solar radiation, receipt and storage of heat transformation.

Earth's heat budget. Interactions amongst various sources of earth's heat.

Week 4
Atmosphere – Hydrosphere. Layering of atmosphere. Atmospheric Circulation.

Week 5
Atmosphere and ocean interaction and its effect on climate Heat transfer in ocean.

Week 6
Global oceanic conveyor belt and its control on earth's climate. Surface and deep circulation Sea ice and glacial ice.

Week 7
Response of biosphere to Earth's climate; Climate change: natural vs. anthropogenic effects Humans and climate change. Future perspectives.

Week 8
Brief introduction to archives of climate change.
Archive based climate change data from the Indian continent.

Week 9
Orbital cyclicity and climate. Milankovitch cycles and variability in the climate.

Week 10
Glacial-interglacial stages
The Last Glacial maximum (LGM) Younger Dryas

Week 11
Pleistocene Glacial-Interglacial cycles. Marine isotope stages.

Week 12
Monsoon. Mechanism of monsoon.

Week 13
Monsoonal variation through time.

Week 14
Factors associated with monsoonal intensity.
Effects of monsoon

Practicals
Study of distribution of major climatic regimes of India on map

Distribution of major wind patterns on World map

Preparation of palaeogeographic maps (distribution of land and sea) of India during specific geological time intervals

Numerical exercises on interpretation of proxy records for paleoclimate

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Orbital cyclicity, monsoon, LGM, hydrosphere, biosphere, lithosphere, cryosphere

FUEL GEOLOGY

(GEOLDSE3)
Discipline Specific Elective – (DSE)
Credits: Theory (4), Practical (2)

Course Objective (2-3)

There is no doubt that petroleum use and exploration of oil is one of the most powerful driving forces in shaping our modern world. Petroleum Geologists are the men and women who know how to understand the earth beneath our feet in order to find oil and natural gas, which are vital resources in our lives. Our r country is big importer of fuel and needs a balanced attention towards this course.

Course Learning Outcomes

1. Types of conventional and non-conventional fuels and consumption trends through time
2. Coal- origin, types and resources
3. Petroleum- origin, traps, occurrence in specific geological domains
4. Non-conventional hydrocarbons
5. Nuclear fuels

Unit 1

Coal: Definition and origin of Coal; Basic classification of coal;
Fundamentals of Coal Petrology - Introduction to lithotypes, microlithotypes and macerals in coal, Proximate and Ultimate analysis.
Suggested Reading;
Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.

Unit 2

Coal as a fuel: Coal Bed Methane (CBM): global and Indian scenario**;** Underground coal Gasification**;** Coal liquefaction
Suggested Reading:
Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.

Unit 3

Petroleum: Chemical composition and physical properties of crudes in nature;
Origin of petroleum; Maturation of kerogen; Biogenic and Thermal effect.
Suggested Reading:
Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press.
Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.

Unit 4

Petroleum Reservoirs and Traps
Reservoir rocks: general attributes and petrophysical properties. Classification of reservoir rocks - clastic and chemical. Hydrocarbon traps: definition, anticlinal theory and

trap theory; Classification of hydrocarbon traps - structural, stratigraphic and combination; Time of trap formation and time of hydrocarbon accumulation. Cap rocks - definition and general properties.Plate tectonics and global distribution of hydrocarbon reservoir.

Suggested Reading:
Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press.
Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.

Unit 5
Other fuels: Gas Hydrate; Nuclear Fuel.

Suggested Reading:
Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press.
Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.

Practicals

1. Study of hand specimens of coal
2. Reserve estimation of coal
3. Section correlation and identification of hydrocarbon prospect
4. Panel and Fence diagrams

References

1. Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.
2. Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press
3. Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.
4. Bastia, R., & Radhakrishna, M. (2012). Basin evolution and petroleum prospectivity of the continental margins of India (Vol. 59). Newnes.

Weekly Teaching Plan

Week 1
Coal: Definition and origin of Coal; Basic classification of coal

Week 2
Fundamentals of Coal Petrology - Introduction to lithotypes, microlithotypes and macerals in coal

Week 3
Proximate and Ultimate analysis

Week 4
Coal as a fuel; Coal Bed Methane (CBM): global and Indian scenario

Week 5
Underground coal gasification; Coal liquefaction

Week 6
Petroleum; Chemical composition and physical properties of crudes in nature

Week 7
Origin of petroleum; Organic and Inorganic theories

Week 8
Maturation of kerogen; Biogenic and Thermal effect

Week 9
Petroleum Reservoirs and Traps; Reservoir rocks: general attributes and petrophysical properties. Classification of reservoir rocks - clastic and chemical. Hydrocarbon traps: Definition, anticlinal theory and trap theory.

Week 10
Classification of hydrocarbon traps - structural, stratigraphic and combination; Time of trap formation and time of hydrocarbon accumulation.

Week 11
Cap rocks - definition and general properties. Plate tectonics and global distribution of hydrocarbon reservoir.

Week 12
Plate tectonics and global distribution of hydrocarbon reservoir; Gas Hydrate

Week 13
Nuclear Fuel

Week 14
Major Indian coal and hydrocarbon reserves

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Natural energy sources, coal, petroleum, traps, nuclear fuel.

URBAN GEOLOGY

(GEOLDSE4)
Discipline Specific Elective – (DSE)
Credits: Theory (4), Practical (2)

Course Objective (2-3)

It is an emerging discipline in an increasingly urbanized world, particularly fast developing nation like India. In the broadest terms, urban geology is the application of the earth sciences to problems arising at the nexus of the geosphere, hydrosphere and biosphere within urban and urbanizing areas.

Course Learning Outcomes

Urban geology draws on the all branches of the earth sciences, from stratigraphy to geochemistry and hydrogeology to geophysical exploration techniques; and it often makes linkages to the biological and environmental sciences.

1. Linking geology to the infrastructure developments
2. Linking geology to upkeep and optimization of natural resources like water and soil
3. Identifying possible domains of natural hazard in the context of town planning

Unit 1

Geology and Society: Necessity of Geology in Urban life. Geology in Urban Constructions
Geotechnical feature and mapping for subsurface in Metropolitan areas
Building materials, Excavation and cutting in urban areas.

Suggested Readings:
Huggenberger, P. & Eptin, J. (2011). Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management, Springer.
Lollino, G. et al. (Ed.), Engineering Geology for Society and Territory. Springer

Unit 2

Geology and Urban Agriculture
Soil studies, Chemistry and geochemistry of soil in relation to ground water and fertilizer
Effect of pollutants on vegetable contamination

Suggested Readings:
Huggenberger, P. & Eptin, J. (2011). Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management, Springer.
Lollino, G. et al. (Ed.), Engineering Geology for Society and Territory. Springer

Unit 3

Urban land use; Geotechnical site characterization, Geotechnical and land use mapping, Decision making in urban land use, Geological problems in construction of underground structures in urban areas.

Urban Tunnelling: Tunnelling for road and rail in urban areas; Methods, Equipments, Importance of Geology

Suggested Readings:
Huggenberger, P. & Eptin, J. (2011). Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management, Springer.
Lollino, G. et al. (Ed.), Engineering Geology for Society and Territory. Springer

Unit 4

Urban water: Water lagging in built-up areas, Source of water, Standards for various uses of Water; Sources of contamination; Waste waters: Sources and its disinfection and treatment, Ground water surveys and resource development.

Suggested Readings:
Huggenberger, P. & Eptin, J. (2011). Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management, Springer.
Lollino, G. et al. (Ed.), Engineering Geology for Society and Territory. Springer

Unit 5

Urban wastes and Treatment, Geotechnical characterization for waste sites, Domestic waste, Industrial waste, Mine drainage, Power production waste, radioactive waste, Need for special purpose mapping for selection of waste disposal sites.

Suggested Readings:
Huggenberger, P. & Eptin, J. (2011). Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management, Springer.
Lollino, G. et al. (Ed.), Engineering Geology for Society and Territory. Springer

Unit 6

GIS in Urban Geology: GIS-An introduction, Application in Urban development, Application in land use, Application in GW Exploration.
Precaution from seismic hazard in urban planning
Seismic Hazards: Micro-zonations of hazard based on engineering geological features.
Urban- subservice network.

Suggested Readings:
Huggenberger, P. & Eptin, J. (2011). Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management, Springer.
Lollino, G. et al. (Ed.), Engineering Geology for Society and Territory. Springer

Practicals

1. Map Reading
2. Ground water flow direction estimation
3. Case studies of Urban flood; Flood hydrographs
4. Case studies of urban planning

References

1. Huggenberger, P. & Eptin, J. (2011). Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management, Springer.
2. Lollino, G. et al. (Ed.), Engineering Geology for Society and Territory. Springer

Weekly Teaching Plan

Week 1
Geology and Society: Necessity of Geology in Urban life. Geology in Urban Constructions

Week 2
Geotechnical feature and mapping for subsurface in Metropolitan areas
Building materials, Excavation and cutting in urban areas.

Week 3
Geology and Urban Agriculture
Soil studies, Chemistry and geochemistry of soil in relation to ground water and fertilizer

Week 4
Effect of pollutants on vegetable contamination

Week 5
Urban land use: Geotechnical site characterization, Geotechnical and land use mapping, Decision making in urban land use.

Week 6
Geological problems in construction of underground structures in urban areas.

Week 7
Urban Tunnelling: Tunnelling for road and rail in urban areas, Method, Equipments, Importance of Geology

Week 8
Urban water: Water lagging in built-up areas, Source of water, Standards for various uses of Water; Sources of contamination.

Week 9
Waste waters: Sources and its disinfection and treatment; Ground water surveys and resource development.

Week 10
Urban wastes and Treatment: Geotechnical characterization for waste sites, Domestic waste, Industrial waste.

Week 11
Mine drainage, Power production waste, radioactive waste, Need for special purpose mapping for selection of waste disposal sites.

Week 12
GIS in Urban Geology: GIS-An introduction, Application in Urban development, Application in land use, Application in GW Exploration.

Week 13
Precaution from seismic hazard in urban planning
Seismic Hazards: Micro-zonations of hazard based on engineering geological features.

Week 14
Urban- subservice network.

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Urban planning, GIS, natural hazard, pollution, engineering geology, earthquake

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EVOLUTION OF LIFE THROUGH TIME

(GEOLDSE 5)

Discipline Specific Elective – (DSE)

Course Objective (2-3)

To understand the evolution of life through geological time

To understand the role of geological processes in the evolution of life

To learn about major biological events of the geological past

Course Learning Outcomes

Students will be able:

To understand how life originated and evolved through time.

To learn how fossilization processes operate in nature.

To interpret how organisms had responded to changes in environment and climate in the geological past.

To learn about major mass extinction events in the Phanerozoic history of life

Unit 1

Life through ages; Fossils and chemical remains of ancient life; Geological Time Scale with emphasis on major bio-events; Fossilization processes and modes of fossil preservation; Exceptional preservation sites.

Suggested Reading:

Benton, M.J. & Harper, D.A.T. (2016). Introduction to Paleobiology and the fossil record. Wiley

Unit 2

Geobiology: Biosphere as a system, processes and products; Biogeochemical cycles; Abundance and diversity of microbes, extremophiles; Microbes-mineral interactions, microbial mats.

Suggested Reading:

Canfield, D.E. & Konhauser, K.O. (2012). Fundamentals of Geobiology, Blackwell.

Unit 3

Origin of life; possible life sustaining sites in the solar system, life sustaining elements and isotope records.

Archean life: Earth's oldest life, Transition from Archean to Proterozoic, the oxygen revolution and radiation of life

Precambrian macrofossils – The garden Ediacara; Snow Ball Earth Hypothesis

Suggested Reading:

Benton, M.J. & Harper, D.A.T. (2016). Introduction to Palaeobiology and the fossil record. Wiley.
Stanley, S.M. & Luczaj, J.A. (2014). Earth System History (4th Edition). W.H.Freeman (Macmillan)

Cowen, R. (2000). History of Life. Wiley-Blackwell.
Lumine, J.I. (1999). Earth-Evolution of a Habitable World, Cambridge University Press.

Unit 4

Paleozoic Life: The Cambrian Explosion. Biomineralization and skeletalization; Origin of vertebrates and radiation of fishes; Origin of tetrapods - Life out of water

Suggested Reading:

Lieberman, B.S. & Kaesler, R. (2010). Prehitoric Life-Evolution and the Fossil Record, Wiley-Blackwell.

Cowen, R. (2000). History of Life. Wiley-Blackwell

Unit 5

Mesozoic Life: Life after the largest (P/T) mass extinction, life in the Jurassic seas; Origin of mammals; Rise and fall of dinosaurs; Origin of birds; and spread of flowering plants.

Suggested Reading:

Lieberman, B.S. & Kaesler, R. (2010). Prehitoric Life-Evolution and the Fossil Record. Wiley-Blackwell.

Cowen, R. (2000). History of Life. Wiley-Blackwell

Unit 6

Cenozoic Life: Aftermath of end Cretaceous mass extinction – radiation of placental mammals Evolution of modern grasslands and co-evolution of hoofed grazers; Rise of modern plants and vegetation; Back to water – Evolution of Whales; The age of humans; Hominid dispersals and climate setting

Suggested Reading:

Stanley, S.M. & Luczaj, J.A. (2014). Earth System History (4th Edition), W.H.Freeman (Macmillan)
Cowen, R. (2000). History of Life. Wiley-Blackwell.

Practicals

1. Study of modes of fossil preservation
2. Study of fossils from different stratigraphic levels
3. Exercises related to major evolutionary trends in important groups of animals and plants

References

Benton, M.J. & Harper, D.A.T. (2016). Introduction to Palaeobiology and the fossil record. Wiley.
Stanley, S.M. & Luczaj, J.A. (2014). Earth System History (4th Edition), W.H.Freeman (Macmillan)
Cowen, R. (2000). History of Life. Wiley-Blackwell.

Lumine, J.I. (1999). Earth-Evolution of a Habitable World, Cambridge University Press.

Canfield, D.E. & Konhauser, K.O., 2012 Fundamentals of Geobiology, Blackwell.

Cockell, C., Corfield, R., Edwards, N. & Harris, N. (2007). An Introduction to the Earth-Life System Cambridge University Press.

Weekly Teaching Plan

Week 1
Fossils and chemical remains of ancient life, Fossilization processes and modes of fossil preservation.

Week 2
Geological Time Scale with emphasis on major bio-events; Life through ages.

Week 3
Exceptional preservation sites- age and fauna.

Week 4
Geobiology: Biosphere as a system, processes and products; Biogeochemical cycles; Abundance and diversity of microbes, extremophiles; Microbes-mineral interactions, microbial mats

Week 5
Origin of life; Possible life sustaining sites in the solar system, life sustaining elements and isotope records

Archean life: Earth's oldest life, Transition from Archean to Proterozoic, the oxygen revolution and radiation of life

Week 6
Precambrian macrofossils – The garden Ediacara; Snow Ball Earth Hypothesis

Week 7

The Cambrian Explosion; Biomineralization and skeletalization

Week 8

Origin of vertebrates and radiation of fishes; Origin of tetrapods - Life out of water

Week 9
Life after the largest (P/T) mass extinction, life in the Jurassic seas

Week 10
Origin of mammals; Rise and fall of dinosaurs

Week 11

Origin of birds; and spread of flowering plants

Week 12
Aftermath of end Cretaceous mass extinction – radiation of placental mammals;

Evolution of modern grasslands and co-evolution of hoofed grazers

Week 13

Rise of modern plants and vegetation**;** Back to water – Evolution of Whales

Week 14
The age of humans; Hominid dispersals and climate setting

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords

GOE, Ediacaran fauna, Snow Ball Earth, Cambrian Explosion of life, Mass Extinctions

RIVER SCIENCE

(GEOLDSE 6)
Discipline Specific Elective – (DSE)
Credits: Theory (4), Practical (2)

Course Objective (2-3)

To understand the life cycle of a river especially in relation to societal development. To understand the process of erosion and transportation of sediments and its connection with the landforms

Course Learning Outcomes

1. Rivers through geological time
2. Fluvial degradational and aggradational processes
3. Landforms associated with the rivers

Unit 1

Stream hydrology: Basic stream hydrology

Physical properties of water, sediment and channel flow

River discharge, River hydrographs (UH, IUH, SUH, GIUH) and its application in hydrological analysis; Flood frequency analysis

Suggested Reading:
Fryirs and Brierly (2013) Geomorphology and river management, Wiley-Blackwell Pub.

Unit 2

River basin: Sediment source and catchment erosion processes; Sediment load and sediment

Yield; Sediment transport processes in rivers; Erosion and sedimentation processes in channel.

Suggested Readings:
Fryirs and Brierly (2013) Geomorphology and river management, Wiley-Blackwell Pub.
Julien, P.Y. (2002) River Mechanics. Cambridge University Press.

Unit 3

Drainage: Drainage network; Quantitative analysis of network organization - morphometry

Random Topology (RT) model and fractal analysis; Role of drainage network in flux transfer

Evolution of drainage network in geological time scale.

Suggested Reading:
Fryirs and Brierly (2013) Geomorphology and river management, Wiley-Blackwell Pub.

Unit 4

Rivers in time and space: River diversity in space, Patterns of alluvial rivers - braided, meandering and anabranching channels, Dynamics of alluvial rivers; Channel patterns in stratigraphic sequences;

Different classification approaches in fluvial geomorphology and its applications.

Suggested Reading:
Fryirs and Brierly (2013) Geomorphology and river management, Wiley-Blackwell Pub.

Unit 5

Channels and Landscapes: Bedrock channels, Bedrock incision process; River response to climate, tectonics and human disturbance; Bedrock channel processes and evolution of fluvial landscapes.

Suggested Reading:
Fryirs and Brierly (2013) Geomorphology and river management, Wiley-Blackwell Pub.

Unit 6

Fluvial hazards: Integrated approach to stream management.

Introduction to river ecology.

Suggested Reading:
Fryirs and Brierly (2013) Geomorphology and river management. Wiley-Blackwell Pub.

Practicals

Stream power calculation

Longitudinal profile analysis

Hydrograph analysis and other related problems

References

1. Fryirs and Brierly (2013) Geomorphology and river management, Wiley-Blackwell Pub.
2. Julien, P.Y. (2002) River Mechanics, Cambridge University Press.

Weekly Teaching Plan

Week 1

Stream hydrology: Basic stream hydrology

Physical properties of water, sediment and channel flow

Week 2

River discharge, River hydrographs (UH, IUH, SUH, GIUH) and its application in hydrological analysis; Flood frequency analysis

Week 3

River basin: Sediment source and catchment erosion processes

Week 4

Sediment load and sediment Yield; Sediment transport processes in rivers

Week 5

Erosion and sedimentation processes in channel.

Week 6

Drainage: Drainage network; Quantitative analysis of network organization - morphometry

Random Topology (RT) model and fractal analysis

Week 7

Role of drainage network in flux transfer; Evolution of drainage network in geological time scale.

Week 8

Rivers in time and space: River diversity in space, Patterns of alluvial rivers - braided, meandering and anabranching channels, Dynamics of alluvial rivers.

Week 9

Channel patterns in stratigraphic sequences; Different classification approaches in fluvial geomorphology and its applications.

Week 10

Channels and Landscapes: Bedrock channels, Bedrock incision process; Bedrock channel processes and evolution of fluvial landscapes.

Week 11

River response to climate, tectonics and human disturbance.

Week 12

Fluvial hazards: Integrated approach to stream management.

Week 13

Introduction to river ecology.

Week 14

Introduction to river ecology.

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Hydrology, stream power, river basin, fluvial hazards, aggradation, erosion

INTRODUCTION TO GEOPHYSICS

(GEOLDSE 7)
Discipline Specific Elective – (DSE)
Credits: Theory (4), Practical (2)

Course Objective (2-3)

To develop an understanding of solid earth and interior of earth and to learn about the basic geophysical exploration techniques.

Course Learning Outcomes

1. Physical properties of the natural material
2. Earth's interior through indirect methods
3. Geophysical exploration methods

Unit 1

Geology and Geophysics: Interrelationship between geology and geophysics, Role of geological and geophysical data in explaining geodynamical features of the earth.

Suggested Reading:
Ramachandra Rao, M.B. (1975). Outlines of Geophysical Prospecting - A manual for geologists. Prasaranga, University of Mysore, Mysore.
Bhimasankaram V.L.S. (1990). Exploration Geophysics - An Outline by Association of Exploration Geophysicists, Osmania University, Hyderabad.
Dobrin, M.B. (1984). An introduction to Geophysical Prospecting. McGraw-Hill, New Delhi.

Unit 2

General and Exploration geophysics: Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications; Concepts and Usage of corrections in geophysical data

Suggested Reading:
Dobrin, M.B. (1984). An introduction to Geophysical Prospecting. McGraw-Hill, New Delhi

Unit 3

Geophysical field operations: Different types of surveys, grid and route surveys, profiling and sounding techniques; Scales of survey, Presentation of geophysical data

Suggeted Reading:
Dobrin, M.B. (1984). An introduction to Geophysical Prospecting. McGraw-Hill, New Delhi

Unit 4

Application of Geophysical methods
Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics.
Suggested Reading:
Telford, W. M., Geldart, L. P. & Sheriff, R. E. (1990). Applied geophysics (Vol. 1). Cambridge University Press.

Unit 5

Geophysical anomalies: Correction to measured quantities, geophysical, anomaly, regional

and residual (local) anomalies, factors controlling anomaly, and depth of exploration

Suggested Reading:
Dobrin, M.B. (1984). An introduction to Geophysical Prospecting. McGraw-Hill, New Delhi
Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). Applied geophysics (Vol. 1). Cambridge university press.

Unit 6

Integrated geophysical methods: Ambiguities in geophysical interpretation, planning and execution of geophysical surveys

Suggested Reading:
Lowrie, W. (2007). Fundamentals of geophysics. Cambridge University Press.

Practicals

Anomaly and background- Graphical method
Study and interpretation of seismic reflector geometry
Problems on gravity anomaly

References

1. Outlines of Geophysical Prospecting - A manual for geologists by Ramachandra Rao, M.B., Prasaranga, University of Mysore, Mysore, 1975.

2. Bhimasankaram, V.L.S. (1990). Exploration Geophysics - An Outline by, Association of Exploration Geophysicists, Osmania University, Hyderabad.

3. Dobrin, M.B. (1984) An introduction to Geophysical Prospecting, McGraw-Hill, New Delhi.

4. Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). Applied geophysics (Vol. 1), Cambridge University press.

5. Lowrie, W. (2007). Fundamentals of geophysics. Cambridge University Press.

Weekly Teaching plan

Week 1
Geology and Geophysics: Interrelationship between geology and geophysics, Role of geological And geophysical data in explaining geodynamical features of the earth.

Week 2
General and Exploration geophysics

Week 3
Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications.

Week 4
Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications.

Week 5
Different types of geophysical methods - gravity, magnetic, electrical and seismic;
their principles and applications.

Week 6
Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications

Week 7
Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications

Week 8
Concepts and Usage of corrections in geophysical data

Week 9
Geophysical field operations: Different types of surveys, grid and route surveys, profiling and sounding techniques; Scales of survey, Presentation of geophysical data

Week 10
Application of Geophysical methods
Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics

Week 11
Application of Geophysical methods; Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics

Week 12
Geophysical anomalies; Correction to measured quantities, geophysical, anomaly, regional and residual (local) anomalies.

Week 13
Factors controlling anomaly, and depth of exploration

Week 14
Integrated geophysical methods
Ambiguities in geophysical interpretation, planning and execution of geophysical surveys.

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Physical properties, solid earth, density, passive and active sources, geophysical logging

BASIC FIELD TRAINING

(GEOLSE 1)

Skill-Enhancement Course - (SEC) Credits: 2

Course Objective (2-3)

To introduce students to the natural occurrence of rocks and minerals

Course Learning Outcomes

1. teaching attitudes of linear and planar structures
2. Introduction to front and back bearing and marking location on map
3. Map reading

Unit 1

Identification of rocks and minerals

Unit 2

Orientation of Topographic sheet in field, marking location in toposheet; Bearing (Front and back). Concepts of map reading, Distance, height and pace approximation

Unit 3

Identification of rock types in field; structures and texture of rocks; Use of hand lens

Unit 4

Basic field measurement techniques: Bedding dip and strike, litholog measurement
Reading contours and topography.

Teaching Learning Process
Demonstration and measurement

Assessment Methods
Field report and viva voce

Keywords
Clinometer, Brunton compass, hand lens, toposheet, thematic maps

GEOLOGICAL MAPPING

(GEOLSE 2)

Skill-Enhancement Course - (SEC) Credits: 2

Course Objective (2-3)
Preparing thematic mappers

Course Learning Outcomes

1. Accurate location matching on ground and map
2. Accurate measurements of geological features
3. Preparation of thematic maps

Unit 1
Geological mapping, stratigraphic correlation

Unit 2
Primary (scalars and vectors) and secondary structures (linear and planar)

Unit 3
Trend, plunge, Rake/Pitch

Unit 4
Stereoplots of linear and planar structures, Orientation analyses

Teaching Learning Process
Demonstration and measurements

Assessment Methods
Report and viva voce

Keywords
Fold axis, azimuth, plunge, axial plane cleavage, throw, hade

ECONOMIC GEOLOGY (FIELD)

(GEOLSE 3)

Skill Enhancement Course – (SEC) Credits: 2

Course Objective (2-3)

To introduce and acquaint the student to the natural occurrences of economic mineral deposits linking theory of mineral deposit formation to field-based interpretations

Course Learning Outcomes

1. Demonstration of field occurrence of mineral deposits- over ground as well as Underground

2. Identification and recording of evidence of mineralization such as alteration zones etc.
3. Learning the role of geology in mining of the mineral deposits

Unit 1
Visit to mineral deposits (one metallic and one industrial mineral deposit) and study of ore mineralogy as well as relation with the host.

Unit 2
Ore formation process; Basic techniques of surveying, concept of outcrop map.

Unit 3
Visit to underground or open cast mine.
Practical experience of mining methods.

Unit 4
Underground mapping/Bench mapping
Isopach and Isochore maps.

Teaching Learning Process
Demonstration and measurements

Assessment Methods
Field report and viva voce

Keywords
Mineral deposit, ore, gangue, mine, exploration, beneficiation, smelting

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HIMALAYAN GEOLOGY (FIELD)

(GEOLSE 4)

Skill Enhancement Course – (SEC) Credits: 2

Course Objective (2-3)

To observe, identify and map the lithologic, structural and geomorphic elements of an evolving ororgen.

Course Learning Outcomes

1. To recognize imprints of major tectonic processes in orogens
2. To relate the structural and lithological elements to the structural level of an orogenic mountain
3. To identify longitudinal boundaries of the Himalayas and to distinguish the transverse elements

Unit 1

Identification and characterization of major structural boundaries in Himalaya viz. MBT, MFT etc.

Unit 2
Field work along any suitable transect of Himalayan foreland

Unit 3
Field transect in the Siwalik Hills

Unit 4
Identification of Himalayan and pre-Himalayan elements

Teaching Learning Process
Demonstration and measurements

Assessment Methods
Field report and viva voce

Keywords
Orogen, Lesser Himalayas, Higher Himalayas, Central Crystallines, Trans-Himalayas, thrust, Tertiary metamorphism and magmatism

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PRECAMBRIAN GEOLOGY (FIELD)

(GEOLSE 5)

Skill Enhancement Course – (SEC) Credits: 2

Course Objective (2-3)

The aim of the course is to acquaint students to the craton, mobile belts and within craton sedimentary basins of the shield areas.

Course Learning Outcomes

1. To distinguish elements of mobile belts or older orogens in areas of low relief
2. To understand basic elements of a stabilized cratons
3. To understand role of extensional tectonics in such regions and
4. To observe features of intracratonic sedimentary basins

Unit 1
Field transect in any Precambrian terrain and mapping of structural patterns

Unit 2
Study of craton ensemble including basic intrusive suites

Unit 3
Precambrian sedimentary basin

Unit 4
Basement-Cover relation in: a. fold belts, b. sedimentary successions

Teaching Learning Process
Demonstration and measurements

Assessment Methods
Field report and viva-voce

Keywords
Shield, craton, mobile belt, sedimentary basin, basement-cover relationship, extensional tectonics

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VISIT TO ENGINEERING PROJECT SITE

(GEOLSE 6)
Skill Enhancement Course – (SEC) Credits: 2

Course Objective (2-3)

To understand necessity of geological inputs in major engineering projects

Course Learning Outcomes

1. Site selection parameters for major infrastructure projects such as dams, tunnels, roads, railways and power projects
2. Foundation mapping
3. Reservoir mapping
4. Treatment methods for weak material

Unit 1
Geological mapping of a project site (Dam sites, Tunnel alignments etc.)

Unit 2
On site visit & to study various geotechnical aspects related to the project site.

Unit 3
Identification of geotechnical problems of a project site and remedial measures to be taken.

Unit 4
Identification of environmental problems of a project site and remedial measures to be taken.

Unit 5
Computation of rock mass Properties (RQD, RSR, RMR &Q) in the field.

Unit 6

Identification of potential suspected/probable sites of Natural Disaster and suggestions about corrective/preventive measures.

Teaching Learning Process
Demonstration and measurements

Assessment Methods
Field report and viva voce

Keywords
Dams, tunnels, reservoir, grouting, large-scale mapping, RQR

STRATIGRAPHY AND PALAEONTOLOGY (FIELD)

(GEOLSE 7)

Skill Enhancement Course – (SEC) Credits: 2

Course Objective (2-3)

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

Course Learning Outcomes

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

Unit 1
Field training in Phanerozoic sedimentary basins of India

Unit 2
Documentation of stratigraphic details in the field

Unit 3
Collection of sedimentological, stratigraphic and paleontological details and their representation and interpretation

Unit 4
Facies concept and its spatio-temporal relation (Walther’s Law) and concept of facies distribution at basinal-scale

Unit 5
Fossils sampling techniques and their descriptions

Teaching Learning Process
Demonstration and measurements

Assessment Methods
Field report and viva-voce

Keywords
Order of superposition, sedimentation, fossils, biostratigraphy, Walther's law

ESSENTIALS OF GEOLOGY

(GEOLGE1)
Generic Elective – (GE)
Credits: 6, Theory (4), Practical (2)

Course Objective (2-3)

1. Interactive and interdisciplinary nature of geology

2. Interplanetary scope of geology

3. Introduction to atmosphere, hydrosphere, biosphere and lithosphere

Course Learning Outcomes

1. Earth, its origin and concept of geological time
2. Formation of planets and solar system
3. Composition of inner as well as surficial components of planet earth
4. Major geomorphic features, and compositions of various parts of earth and major earth processes

Unit 1

Introduction to geology, scope, sub-disciplines and relationship with other branches of sciences

Suggested Reading:
Holmes, A. (1992). Principles of Physical Geology, 1992, Chapman and Hall.

Unit 2

Earth in the solar system, origin; Earth's size, shape, mass, density, rotational and evolutional parameters Solar System- Introduction to Various planets - Terrestrial Planets Solar System- Introduction to Various planets - Jovian Planets Internal constitution of the earth - core, mantle and crust.

Suggested Reading:
Holmes, A. (1992). Principles of Physical Geology, 1992, Chapman and Hall.

Unit 3

Convections in the earth's core and production of magnetic field; Composition of earth in comparison to other bodies in the solar system

Suggested Reading:
Emiliani, C. (1992). Planet Earth, Cosmology, Geology and the Evolution of Life and

Environment, Cambridge University Press.

Unit 4
Origin and composition of hydrosphere and atmosphere; Origin of biosphere;
Origin of oceans, continents and mountains.
Suggested Reading:
Gross, M.G. (1977).Oceanography: A view of the Earth, Prentice Hall.

Unit 5
Age of the earth; Radioactivity and its application in determining the age of the Earth, rocks, minerals and fossils.

Suggested Reading:
Holmes, A. (1992). Principles of Physical Geology, 1992, Chapman and Hall.
Practicals

1. Study of major geomorphic features and their relationships with outcrops through physiographic models.
2. Detailed study of topographic sheets and preparation of physiographic description of an area
3. Study of soil profile of any specific area
4. Study of distribution of major lithostratigraphic units on the map of India
5. Study of distribution of major dams on map of India and their impact on river systems
6. Study of major ocean currents of the World
7. Study of seismic profile of a specific area and its interpretation

References

1. Holmes, A. (1992). Principles of Physical Geology, 1992, Chapman and Hall.
2. Emiliani, C. (1992). Planet Earth, Cosmology, Geology and the Evolution of Life and Environment, Cambridge University Press.
3. Gross, M.G. (1977). Oceanography: A view of the Earth, Prentice Hall.

Weekly Teaching plan

Week 1
Introduction to geology: scope, sub-disciplines
Relationship with other branches of sciences

Week 2
Earth in the solar system, origin; Earth's size, shape, mass, density, rotational and evolutional Parameters.

Week 3
Solar System- Introduction to Various planets - Terrestrial Planets

Week 4
Solar System- Introduction to Various planets - Jovian Planets
Internal Constitution of the Earth - core, mantle and crust

Week 5
Convections in the Earth's core and production of magnetic field
Composition of Earth in comparison to other bodies in the solar system

Week 6
Origin and composition of hydrosphere and atmosphere

Week 7
Oxygenation of atmosphere and hydrosphere, Origin of biosphere

Week 8
Origin of oceans, continents and mountains

Week 9
Age of the Earth; Geological Time Scale; Irreversible changes through geological history

Week 10
Radioactivity and its application in determining the age of the Earth, rocks, minerals and fossils.

Week 11
Introduction to different types of rocks in geological record; Rocks as time archive

Week 12
Introduction to the concept of stratigraphy; Major time divisions in the Earth history

Week 13
Geomorphology and Physiography; Broad physiographic subdivisions of India

Week 14
Introduction to the concept of 'Earth System Science'.

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Planetary earth, lithosphere, hydrosphere, biosphere, atmosphere, geochronology

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ROCKS AND MINERALS

(GEOLGE2)
Generic Elective – (GE)
Credits: 6, Theory (4), Practical (2)

Course Objective (2-3)

1. Introduction of different types of rocks and Minerals

2. General idea on processes involved in formation of minerals and rocks

3. Structure of Earth and distribution of rocks

Course Learning Outcomes

1. Students will be acquainted with different types of rocks and minerals
2. Students will come to know veracity of geological processes and formation of different rock types.
3. Students will know structure of the Earth and distribution of rocks

Unit 1

Minerals-Definitions, Physical properties of minerals Mineralogical structure of earth, planetary minerals and native elements

Suggested Reading:
Klein, C. & Philpotts, A. (2013). Earth Materials- Introduction to Mineralogy and Petrology, Cambridge University Press.

Unit 2

Mineral structures; Mineralogy of the Earth's crust, mantle and core.

Suggested Reading:
Klein, C. & Philpotts, A. (2013). Earth Materials- Introduction to Mineralogy and Petrology, Cambridge University Press.

Unit 3

Nature of light and principles of optical mineralogy; Optical classification of minerals.

Suggested Reading:
Klein, C. & Philpotts, A. (2013). Earth Materials- Introduction to Mineralogy and Petrology, Cambridge University Press.

Unit 4

An overview of environmental and radiation mineralogy, biomineralisation and gemmology.

Suggested Reading:
Klein, C. & Philpotts, A. (2013). Earth Materials- Introduction to Mineralogy and Petrology, Cambridge University Press.

Unit 5

Rocks- Definitions and types, Basics of rock formation. Igneous rock- magma generation and differentiation

Suggested Reading:
Klein, C. & Philpotts, A. (2013). Earth Materials- Introduction to Mineralogy and Petrology, Cambridge University Press.

Unit 6

Sedimentary rocks- surface processes and sedimentary environments
Metamorphic rocks- chemical system and types of metamorphism

Rock cycle-interactions between plate tectonics and climate systems

Suggested Reading:
Klein, C. & Philpotts, A. (2013). Earth Materials- Introduction to Mineralogy and Petrology, Cambridge University Press.

Practicals

1. Study of physical properties of minerals
2. Introduction to optical microscopy
3. Study of optical properties of minerals
4. Study of physical properties of rocks
5. Study of optical properties of rock under thin sections
6. Understanding crystal symmetry via wooden models
7. Stereographic projection of mineral faces
8. Mineral formula calculation
9. Crystal chemical calculation
10. Introduction to analytical techniques for rock and mineral study.

Weekly Teaching plan

Week 1
Minerals-Definitions, Physical properties of minerals

Week 2
Mineralogical structure of earth

Week 3
Planetary minerals and native elements

Week 4
Mineral structures

Week 5
Mineralogy of the Earth's crust, mantle and core

Week 6
Nature of light and principles of optical mineralogy

Week 7
Optical classification of minerals.

Week 8
An overview of environmental and radiation mineralogy

Week 9
Biomineralisation and gemmology.

Week 10
Rocks- Definitions and types, Basics of rock formation.

Week 11
Igneous rock- magma generation and differentiation

Week 12
Sedimentary rocks- surface processes and sedimentary environments

Week 13

Metamorphic rocks- chemical system and types of metamorphism

Week 14
Rock cycle-interactions between plate tectonics and climate systems

Teaching Learning Process
Regular class lectures, Seminar, Hand specimen study of different rocks and minerals, Assignment

Assessment Methods
Internal Assessment, Seminar, Interactive Discussion, Examination

Keywords
Rock, Mineral, Igneous, sedimentary, Metamorphic, silicate, carbonate, Oxide

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PHYSICS AND CHEMISTRY OF EARTH

(GEOLGE3)
Generic Elective – (GE)
Credits: 6, Theory (4), Practical (2)

Course Objective (2-3)

1. Students will come to know the dynamism in Earth processes
2. Students will be provided an idea about nucleosynthesis and elemental distribution in the Earth
3. Students will be appraised of concepts of Earth's magnetism
4. An idea of chemical character of the Earth

Course Learning Outcomes

Students will be able to understand different physical and chemical processes of the Earth

Unit 1

Earth: Surface features; Continents, continental margins, oceans.

Suggested Readings:
Condie, K.C. (1989). Plate Tectonics and Crustal Evolution, Pargamon Press.
Holmes, A. (1992). Principles of Physical Geology, 1992, Chapman and Hall.

Unit 2
Earth's interior - variation of physical quantities and seismic wave velocity inside the earth, major sub divisions and discontinuities.
Concepts of Isostasy; Airy and Pratt Model

Suggested Readings:
Condie, K.C. (1989). Plate Tectonics and Crustal Evolution, Pargamon Press.
Holmes, A. (1992). Principles of Physical Geology, 1992, Chapman and Hall.

Unit 3

Core: Seismological and other geophysical constraints
The geodynamo - Convection in the mantle
Elements of Earth's magnetism. Secular variation and westward drift
Solar activity and magnetic disturbance

Suggested Readings:
Condie, K.C. (1989). Plate Tectonics and Crustal Evolution, Pargamon Press.
Holmes, A. (1992). Principles of Physical Geology, 1992, Chapman and Hall.

Unit 4

Elements: Origin of elements/nucleosynthesis. Abundance of the elements in the solar system / planet Earth.
Geochemical classification of elements.
Earth accretion and early differentiation
Isotopes and their applications in understanding Earth processes. Stable isotopes: Stable isotope fractionation. Oxygen isotopes; Sublithospheric Mantle (mineralogy/phase transition).

Suggested Readings:
Krauskopf, K. B. & Bird, D.K. (1995). Introduction to Geochemistry. McGraw-Hill.
Faure, G. (1998). Principles and Applications of Geochemistry, 2nd Edition, Prentice Hall.
Anderson, G. M. (1996). Thermodynamics of natural systems. John Wiley

Unit 5

Environmental geochemistry
Geological disposal of nuclear waste
Lead in environment and effect of lead on human health

Suggested Reading:
Krauskopf, K. B., & Bird, D.K. (1995). Introduction to Geochemistry. McGraw-Hill.

Practicals

1. Projection of major elements on binary and triangular diagrams for rock classification.
2. Projection of major element data on Harker's diagram to characterize magmatic Differentiation.
3. Study of trace elements through a) Projection of chondrite/primitive normalized trace elements to characterize sources b) Projection of trace elements on tectonic discrimination diagrams.
4. Understanding Earth structure through behavior of seismic wave propagation
5. Problems on isostasy

References

1. Holmes, A. (1992). Principles of Physical Geology, 1992, Chapman and Hall.
2. Condie, K.C. Plate Tectonics and Crustal Evolution, Pargamon Press, 1989.

3. Krauskopf, K. B. & Bird, D.K. (1995). Introduction to Geochemistry. McGraw-Hill

4. Faure, G. (1998). Principles and Applications of Geochemistry, 2edition, Prentice Hall.

Additional Resources:

1. Anderson, G. M. (1996). Thermodynamics of natural systems, John Wiley & Sons Inc.

2. Steiner, E. (2008). The chemistry maths book, Oxford University Press.

3. Yates, P. (2007) Chemical calculations. 2nd Ed., CRC Press.

Weekly Teaching Plan

Week 1
Earth: surface features

Week 2
Continents, continental margins, oceans

Week 3
Earth's interior - variation of physical quantities and seismic wave velocity inside the earth, major sub divisions and discontinuities.

Week 4
Concepts of Isostasy; Airy and Pratt Model

Week 5
Core: Seismological and other geophysical constraints
The geodynamo - Convection in the mantle

Week 6
Elements of earth's magnetism. Secular variation and westward drift

Week 7
Solar activity and magnetic disturbance

Week 8
Elements: Origin of elements/nucleosynthesis.

Week 9
Abundance of the elements in the solar system / planet earth Geochemical classification of elements.
Earth accretion and early differentiation

Week 10
Isotopes and their applications in understanding Earth processes. Stable isotopes.

Week 11:
Stable isotope fractionation. Oxygen isotopes Sublithospheric Mantle (Mineralogy/phase transitions)

Week 12
Environmental geochemistry

Week 13
Geological disposal of nuclear waste

Week 14:
Lead in environment and effect of lead on human health

Teaching Learning Process
Regular class, Assignment, Seminar, Interactive discussion, Quiz

Assessment Methods
Seminar, Exam, Internal Assessment, Assignment

Keywords
Isostasy, Magnetism, Geodynamo, nucleosynthesis, Isotope.

EARTH RESOURCES AND ECONOMICS

(GEOLGE4)
Generic Elective – (GE)
Credits: 6, Theory (4), Practical (2)

Course Objective (2-3)

To develop an understanding of earth's natural resources and its utilization as a global economic activity.

To understand the need and methods of conservation of finite natural resources

Course Learning Outcomes

1. Distinction between resource and reserves. Introduction to natural processes leading to earth resources
2. Energy- main conventional resources and their distribution
3. Energy- economic implications of asymmetric distribution of natural resources
4. Mineral conservation- principles and techniques

Unit 1

Earth Resources

Resource reserve definitions; mineral, energy and water resources in industries; Economic considerations; Historical perspective and present
A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies.

Suggested Reading:
Fowler, J.M. (1984). Energy and the Environment, McGraw-Hill
Nebojsa Nakicenovic (1998). Global Energy Perspectives, Cambridge University Press.

Unit 2
Definition of Energy: Primary and Secondary Energy; Difference between Energy, Power and Electricity Renewable and Non-Renewable Sources of Energy
The concept and significance of Renewability: Social, Economic, Political and Environmental Dimension of Energy; Development and energy consumption trends

Suggested Reading:
Ghosh, T.K. & Prelas, M.A. (2009). Energy Resources and Systems: Fundamentals and Non-Renewable Resources, Springer.
Wagner, H.J. & Mathur, J. (2009). Introduction to Wind Energy Systems, Springer.

Unit 3
Major Types and Sources of Energy; Resources of Natural Oil and Gas; Coal and Nuclear Minerals
Potential of Hydroelectric Power, Solar Energy, Wind, Wave and Biomass Based power and Energy
Economics of conventional and non-conventional energy resources

Suggested Reading:
Nebojsa Nakicenovic (1998). Global Energy Perspectives, Cambridge University Press.
Ghosh, T.K. & Prelas, M.A. (2009). Energy Resources and Systems: Fundamentals and Non-Renewable Resources, Springer.
Wagner, H.J. & Mathur, J. (2009). Introduction to Wind Energy Systems, Springer.

Unit 4
Energy Sources and Power Generation: Nuclear, Hydroelectric, Solar, Wind and Wave-General principles.
Ground water resources and its role in economic development of a country
Current Scenario and Future Prospects of Solar Power, Hydrogen Power and Fuel Cells.

Suggested Reading:
Nebojsa Nakicenovic (1998). Global Energy Perspectives, Cambridge University Press.
Ghosh, T.K. & Prelas, M.A. (2009). Energy Resources and Systems: Fundamentals and Non-Renewable Resources, Springer.
Wagner, H.J. & Mathur, J. (2009). Introduction to Wind Energy Systems, Springer.

Unit 5
Global metal markets and projections; National mineral policy; Mineral conservation
UNFC classification; Legal, social and environmental aspects affecting the mine cycles.

Suggested Reading:
Nebojsa Nakicenovic (1998). Global Energy Perspectives, Cambridge University Press.
Ghosh, T.K. & Prelas, M.A. (2009). Energy Resources and Systems: Fundamentals and Non-Renewable Resources, Springer.

Practicals

1. Plotting of major Indian oil fields on map of India

2. Problems related to hydroelectric power generation

3. Problems related to assessment of possible oil exploration site from geological maps

4. Problems related to energy demand projection of India and possible mitigation pathways
5. Problems related to biofuel

References

1. Fowler, J.M. (1984). Energy and the Environment, McGraw-Hill

2. Nebojsa Nakicenovic (1998). Global Energy Perspectives, Cambridge University Press.

3. Energy Resources and Systems: Fundamentals and Non-Renewable Resources, Springer

4. Ghosh, T.K. & Prelas, M.A.(2009). Energy Resources and Systems: Fundamentals and Non-Renewable Resources, Springer.
5. Wagner, H.J. & Mathur, J. (2009). Introduction to Wind Energy Systems, Springer.

6. Sorensen, B (2007).Renewable Energy Conversion, Transmission and Storage, Springer.

7. Chatterjee, K.K. (2004). An Introduction to Mineral Economics, New Age Publishers.

Weekly Teaching Plan

Week 1
Earth Resources
Resource reserve definitions; mineral, energy and water resources in industries

Week 2
Economic considerations
Historical perspective and present

Week 3
Classification of mineral deposits with respect to processes of formation in relation to exploration strategies

Week 4
Definition of Energy: Primary and Secondary Energy Difference between Energy, Power and Electricity.

Week 5
Renewable and Non-Renewable Sources of Energy
The concept and significance of Renewability: Social, Economic, Political and Environmental Dimension of Energy

Week 6
The concept and significance of Renewability: Social, Economic, Political and Environmental Dimension of Energy.

Week 7
Development and energy consumption trends

Week 8
Major Types and Sources of Energy
Resources of Natural Oil and Gas

Week 9
Coal and Nuclear Minerals
Potential of Hydroelectric Power, Solar Energy, Wind, Wave and Biomass Based power and Energy
Economics of conventional and non-conventional energy resources

Week 10
Energy Sources and Power Generation: Nuclear, Hydroelectric, Solar, Wind and Wave-General Principles.
Ground water resources and its role in economic development of a country

Week 11
Current Scenario and Future Prospects of Solar Power, Hydrogen Power and Fuel Cells.

Week 12
Global metal markets and projections
National mineral policy

Week 13
UNFC classification
Legal, social and environmental aspects affecting the mine cycles

Week 14
UNFC classification
Legal, social and environmental aspects affecting the mine cycles

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Metals, LME, mine cycle, national mineral policy, UNFC, energy sources.

NATURAL HAZARDS AND DISASTER MANAGEMENT

(GEOLGE5)
Generic Elective - (GE)
Credits: 6, Theory (4), Practical (2)

Course Objectives (2-3)

To create awareness and knowledge base of different types of natural disasters.
To understand the management of natural disasters.

Course Learning Outcomes

1. Definition and types of natural disasters
2. Geological basis of water related disasters such as floods etc.;
3. Landslide hazard mapping techniques
4. Earthquakes and seismic hazards
5. Forecasting and management of natural hazards

Unit 1

The Lithosphere and Related Hazards
Atmospheric Hazards, Hydrosphere and Related Hazards

Suggested Readings:
Bell, F.G. (1999). Geological Hazards, Routledge, London.
Bryant, E. (1985). Natural Hazards, Cambridge University Press.

Unit 2

Concepts of disaster
Types of disaster: natural and manmade - cyclone, flood, land slide, land subsidence, fire and earthquake, tsunami and volcanic eruption

Suggested Readings:
Bell, F.G. (1999). Geological Hazards, Routledge, London.
Bryant, E. (1985). Natural Hazards, Cambridge University Press.

Unit 3

Tectonics and Climate, Meteorite Impacts
Issues and concern for various causes of disasters
Disaster management, mitigation, and preparedness
Techniques of monitoring and design against the disasters
Management issues related to disaster

Suggested Readings:
Bryant, E. (1985). Natural Hazards, Cambridge University Press.
Smith, K. (1992). Environmental Hazards. Routledge, London.

Unit 4

Disaster Management in India
Risk, Vulnerability and Hazard
Mitigation through capacity building
Legislative responsibilities of disaster management; disaster mapping, assessment
Pre-disaster risk & vulnerability reduction
Post disaster recovery & rehabilitation
Disaster related infrastructure development

Suggested Readings:
Bryant, E. (1985). Natural Hazards, Cambridge University Press.
Smith, K. (1992). Environmental Hazards. Routledge, London.
Subramaniam, V. (2001).Textbook in Environmental Science, Narosa International

Unit 5

Hazard Zonation Mapping
Remote-sensing and GIS applications in real time disaster monitoring
Prevention and rehabilitation

Suggested Readings:
Smith, K. (1992). Environmental Hazards. Routledge, London.
Subramaniam, V. (2001).Textbook in Environmental Science, Narosa International

Practicals

The course will also include discussions on topics determined by students in Tutorial. There would be 12 student presentations apart from the lectures. The topics would be assigned to students based on their interest. Practical will be by tutorials

References

1. Bell, F.G. (1999). Geological Hazards, Routledge, London.
2. Bryant, E. (1985). Natural Hazards, Cambridge University Press.
3. Smith, K. (1992). Environmental Hazards. Routledge, London.
4. Subramaniam, V. (2001). Textbook in Environmental Science, Narosa International

Weekly Teaching plan

Week 1
The Lithosphere and Related Hazards

Week 2
Atmospheric Hazards, Hydrosphere and Related Hazards

Week 3
Concepts of disaster
Types of disaster: natural and manmade - cyclone, flood, land slide, land subsidence, fire and earthquake, tsunami and volcanic eruption.

Week 4
Concepts of disaster
Types of disaster: natural and manmade - cyclone, flood, land slide, land subsidence, fire and earthquake, tsunami and volcanic eruption.

Week 5
Tectonics and Climate, Meteorite Impacts
Issues and concern for various causes of disasters

Week 6
Disaster management, mitigation, and preparedness
Techniques of monitoring and design against the disasters
Management issues related to disaster

Week 7
Disaster management, mitigation, and preparedness
Techniques of monitoring and design against the disasters
Management issues related to disaster

Week 8

Disaster Management in India
Risk, Vulnerability and Hazard

Week 9
Mitigation through capacity building
Legislative responsibilities of disaster management; disaster mapping, assessment
Pre-disaster risk & vulnerability reduction

Week 10
Post disaster recovery & rehabilitation
Disaster related infrastructure development

Week 11
Post disaster recovery & rehabilitation
Disaster related infrastructure development

Week 12
Hazard Zonation Mapping

Week 13
Remote-sensing and GIS applications in real time disaster monitoring
Prevention and rehabilitation

Week 14
Remote-sensing and GIS applications in real time disaster monitoring
Prevention and rehabilitation.

Practicals will be by tutorials

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Natural disasters, hazard zonation, landslides, floods, earthquakes.

EARTH SURFACE PROCESSES

(GEOLGE6)
Generic Elective (GE)
Credits: 6, Theory (4), Practical (2)

Course Objective (2-3)

The main aim of this course is to look in to the details of the processes shaping the surface

of the Earth. In this course, an understanding of the flow of energy through different geological domains would be provided. It will look in to the details and techniques of the controls on the rates of various surface processes.

Course Learning Outcomes

In this course a student will develop holistic understanding of how earth surface processes work and interact with each other. They will learn about the tools and techniques to measure and interpret rates of earth surface processes. They will also learn the applied aspects of the earth surface processes investigation.

Unit 1
Introduction to earth surface processes
Historical development in concepts, terrestrial relief, scales in geomorphology
Suggested Reading:
Allen, P.A., 1997. Earth Surface Processes, Blackwell publishing.
Bridge, J.S. and Demicco, R.V., 2008. Earth Surface Processes, Landforms and Sediment Deposits, Cambridge University Press.

Unit 2
Energy flow and relative energy of surface processes.
Weathering and formation of soils, karst and speleology, slope and catchment erosion processes, fluvial, aeolian, glacial, peri-glacial and coastal processes and resultant landforms, Water and sediment flux in river systems, Morphometric analysis of drainage basin and geomorphology-hydrology relationship.
Suggested readings:
Allen, P.A., 1997. Earth Surface Processes, Blackwell publishing.
Bridge, J.S. and Demicco, R.V., 2008. Earth Surface Processes, Landforms and Sediment Deposits, Cambridge University Press.
Kale, V.S. and Gupta A 2001 Intoduction to Geomorphology, Orient Longman Ltd.

Unit 3
Rates and changes in surface processes
Techniques for measuring rates of processes: sediment budgeting, rock magnetism, isotope geochemical tracers, cosmogenic nuclides, OSL & C-14 dating

Suggested readings:
Allen, P.A., 1997. Earth Surface Processes, Blackwell publishing.
Bridge, J.S. and Demicco, R.V., 2008. Earth Surface Processes, Landforms and Sediment Deposits, Cambridge University Press.

Unit 4

Controlling factors (tectonics, climate, sea level changes and anthropogenic) and surface Processes, climate change and geomorphic response of fluvial systems of arid and humid regions Geomorphic response to tectonics, sea level/base level change, anthropogenic affects Introduction to Anthropocene
Suggested Readings:
Allen, P.A., 1997. Earth Surface Processes, Blackwell publishing.
Bridge, J.S. and Demicco, R.V., 2008. Earth Surface Processes, Landforms and Sediment Deposits, Cambridge University Press.
Leeder, M. and Perez-Arlucea M 2005 Physical processes in earth and environmental sciences, Blackwell' publishing

Unit 5
Geomorphic concepts in cause-effect relationship

Spatial & temporal scales, geomorphic system, connectivity, buffering, magnitude-frequency concept, time lag, sensitivity, equilibrium, threshold, non-linearity & complexities
Mega geomorphology and process interrelationship
Surface processes and natural hazards; Applied aspects of geomorphology; Introduction to planetary geomorphology.
Suggested Readings:
Allen, P.A., 1997. Earth Surface Processes, Blackwell publishing.
Bridge, J.S. and Demicco, R.V., 2008. Earth Surface Processes, Landforms and Sediment Deposits, Cambridge University Press.
Willcock, P.R., Iverson R M (2003) Prediction in geomorphology ' AGU Publication

Practicals

Mapping of different landforms and interpretation of surface processes
Exercises on hill slope development, fluvial channel, sediment erosion and transport, sediment budgeting, aggradation and degradation events, drainage basin, drainage morphometry
Basic exercises on computation of rate for different surface processes

References

1. Allen, P.A., 1997. Earth Surface Processes, Blackwell publishing.
2. Bridge, J.S. and Demicco, R.V., 2008. Earth Surface Processes, Landforms and Sediment Deposits, Cambridge University Press.
3. Kale, V.S. and Gupta A 2001 Intoduction to Geomorphology, Orient Longman Ltd.
4. Leeder, M. and Perez-Arlucea M 2005 Physical processes in earth and environmental sciences, Blackwell publishing.
5. Willcock, P.R., Iverson R M (2003) Prediction in geomorphology ' AGU Publication.

Weekly Teaching Plan

Week 1
Introduction to earth surface processes; Historical development in concepts, terrestrial relief, scales in geomorphology.

Week 2
Energy flow and relative energy of surface processes. Weathering and formation of soils

Week 3
Karst and speleology, slope and catchment erosion processes

Week 4
Fluvial processes and landforms

Week 5
Aeolian, glacial and peri-glacial processes and landforms

Week 6
Coastal processes and landforms; Water and sediment flux in river systems, Morphometric Analysis of drainage basin and geomorphology-hydrology relationship

Week 7
Rates and changes in surface processes; Techniques for measuring rates of processes: sediment budgeting

Week 8
Rock magnetism, isotope geochemical tracers, Cosmogenic nuclides, OSL & C-14 dating

Week 9
Controlling factors (tectonics, climate, sea level changes and anthropogenic) and surface processes; Climate change and geomorphic response of fluvial systems of arid and humid regions

Week 10
Geomorphic response to tectonics, sea level/base level change, anthropogenic affects

Week 11
Introduction to Anthropocene

Week 12
Geomorphic concepts in cause-effect relationship; Spatial & temporal scales, geomorphic system, connectivity, buffering, magnitude-frequency concept, time lag, sensitivity, Equilibrium, threshold, non-linearity & complexities

Week 13
Mega geomorphology and process interrelationship; Surface processes and natural hazards;

Week 14
Applied aspects of geomorphology; Introduction to planetary geomorphology.

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Surface Processes, cause-effect relationships, geomorphology, geochronology.

FOSSILS AND THEIR APPLICATIONS

(GEOLGE7)
Generic Elective - (GE)
Credits: 6, Theory (4), Practical (2)

Course Objective (2-3)

To study different groups of invertebrate, vertebrate and plant fossils.

To learn the utility of some of these fossils in determining the relative age of sedimentary rocks.

To know the utility of various fossil groups in palaeoecological, palaeoenvironmental, palaeobiogeographical reconstructions.

To understand the role of fossils in hydrocarbon exploration.

Course Learning Outcomes

Student will learn about different types of life forms that existed in the geological past.

Will learn about the evolutionary rates of certain important fossil groups and their role in dividing the rocks into distinctive units based on their stratigraphic ranges.

Learn how fossils can be used in understanding the past environments, ecosystems, climate and distribution of land and sea.

Will also learn about role of fossils in the exploration of hydrocarbons.

Unit 1

Introduction to fossils: Definition of fossil, fossilization processes (taphonomy), taphonomic attributes and it implications, modes of fossil preservation, role of fossils in development of geological time scale and fossils sampling techniques.

Suggested Readings:
Clarkson, E.N.K.(1998). Invertebrate Palaeontology and Evolution George Allen & Unwin
Prothero, D.R. (1998). Bringing fossils to life - An introduction to Paleobiology, McGraw Hill.
Benton, M.J. & Harper, D.A.T. (2016). Introduction to Palaeobiology and the fossil record, Wiley

Unit 2

Species concept: Definition of species, species problem in palaeontology, speciation, methods of description and naming of fossils, code of systematic nomenclature

Suggested Readings:
Raup, D.M. & Stanley, S.M. (1985), Principles of Paleontology, W.H. Freeman and Company
Clarkson, E.N.K. (1998). Invertebrate Palaeontology and Evolution George Allen & Unwin

Unit 3

Introduction to various fossils groups: Brief introduction of important fossils groups: invertebrate, vertebrate, microfossils, spore, pollens and plant fossils. Important age-diagnostic fossiliferous horizons of India

Suggested Readings:
Clarkson, E.N.K. (1998). Invertebrate Palaeontology and Evolution George Allen & Unwin
Benton, M.J. (2005). Vertebrate paleontology (3rd edition). Blackwell Scientific, Oxford.
Shukla, A. C. & Mishra, S.P. (1982).Essentials of Paleobotany.

Unit 4

Application of fossils: Principles and methods of paleoecology, application of fossils in the study of paleoecology, paleobiogeography and paleoclimate; Role of fossils in palaeoenvironmental reconstuctions

Suggested Reading:
Benton, M.J. & Harper, D.A.T. (2016). Introduction to Paleobiology and the fossil record. Wiley.
Raup, D.M. & Stanley, S.M. (1985), Principles of Paleontology, W.H. Freeman and Company

Unit 5

Societal importance of fossils: Implication of larger benthic and micropaleontology in hydrocarbon exploration: identification of reservoirs and their correlation. Application of spore and pollens in correlation of coal seams, spore and pollens as indicator of thermal maturity of hydrocarbons reservoirs, fossils associated with mineral deposits, fossils as an

indicator of pollution.

Suggested Reading:
Jones, R.W. (2011). Applications of Palaeontology - Techniques and Case Studies
Raup, D.M. & Stanley, S.M. (1985), Principles of Paleontology, W.H. Freeman and Company
Shukla, A. C. & Mishra, S.P. (1982).Essentials of Paleobotany

Practicals

1. Study of fossils showing various modes of fossilization
2. Distribution of age diagnostic fossils in India
3. Biostratigraphic correlation

References

1. Schoch, R.M. 1989. Stratigraphy, Principles and Methods,VanNostrand Reinhold.
2. Clarkson, E.N.K.1998. Invertebrate Paleontology and Evolution, George Allen &Unwin
3. Prothero, D.R. 1998. Bringing fossils to life - An introduction to Paleobiology, McGraw Hill.
4. Benton, M.J. 2005. Vertebrate Palaeontology (3rd edition), Blackwell Scientific, Oxford.
5. Colbert's Evolution of the Vertebrates: A History of the Backboned Animals Through Time, Edwin H. Colbert, Michael Morales, Eli C. Minkoff, John Wiley & Sons, 1991.
6. Benton, M.J. & Harper, D.A.T. (2016). Introduction to Palaeobiology and the fossil record. Wiley.
7. Jones, R.W. (2011). Applications of Palaeontology - Techniques and Case Studies
8. Raup, D.M. & Stanley, S.M. (1985), Principles of Paleontology, W.H. Freeman and Company
9. Shukla, A. C. & Mishra, S.P. (1982). Essentials of Palaeobotany

Weekly Teaching Plan

Unit 1
Introduction to fossils; Definition of fossil, fossilization processes (taphonomy),taphonomic attributes and its implications, modes of fossil preservation

Unit 2
Role of fossils in development of geological time scale and fossils sampling techniques.

Unit 3
Species concept; Definition of species, species problem in paleontology, speciation

Unit 4
Methods of description and naming of fossils, code of systematic nomenclature

Unit 5

Introduction to various fossils groups; Brief introduction of important fossil groups: invertebrate

Unit 6
Introduction to vertebrate fossils

Unit 7
Microfossils, spore, pollens and plant fossils.

Unit 8
Important age-diagnostic fossiliferous horizons of India

Unit 9
Application of fossils: Principles and methods of paleoecology, application of fossils in the study of paleoecology, paleobiogeography and paleoclimate

Unit 10
Role of fossils in the reconstruction of palaeoenvironments

Unit 11
Societal importance of fossils: Implication of larger benthic and micropaleontology in hydrocarbon exploration: identification of reservoirs and their correlation.

Unit 12
Application of spore and pollens in correlation of coal seams

Unit 13
Spore and pollens as indicator of thermal maturity of hydrocarbons reservoirs.

Unit 14
Fossils associated with mineral deposits, fossils as an indicator of pollution.

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Fossils, Biostratigraphy, Palaeoecology, Bathymetry, Palaeoclimate, Hydrocarbon Exploration, Palaeobiogeography.

INTRODUCTION TO SUSTAINABILITY

(GEOLGE8)
Generic Elective - (GE)
Credits: 6, Theory (4), Practical (2)

Course Objective (2-3)

The main aim of this course is to introduce the fundamental concepts of sustainability. It will discuss about the ecosystems, energy, and natural resources.

Course Learning Outcomes

A student will learn about the concept of sustainability. They will also learn about the challenges faced by present and future generations regarding natural resources. They will also learn about the measures that can be taken to meet the challenges.

Unit 1

Introduction to Sustainability; basic concepts; Human Population – Past and Future trends

Suggested Readings:
Rogers, P.P., K. F. Jalal, and J.A. Boyd. 2007. An Introduction to Sustainable Development. Earthscan Publishers, 416 pp.
Brown, L. 2009. Plan B 4.0. Norton Publishers, New York. (The entire book is available in pdf format: http://www.earthpolicy.org/images/uploads/book_files/pb4book.pdf)

Unit 2
Ecosystems; Extinctions and Tragedy of Commons; Climate and Energy; Water Resources and Agriculture

Suggested Readings:
Rogers, P.P., K. F. Jalal, and J.A. Boyd. 2007. An Introduction to Sustainable Development. Earthscan Publishers, 416 pp.
Brown, L. 2009. Plan B 4.0. Norton Publishers, New York. (The entire book is available in pdf format: http://www.earthpolicy.org/images/uploads/book_files/pb4book.pdf)

Unit 3

National Resources Accounting Environmental Economics and Policy Measuring Sustainability; Systems interconnectivity among Primary Sustainability challenges; Sustainability Solutions: Some examples

Suggested Reading:
Rogers, P.P., K. F. Jalal, and J.A. Boyd. 2007. An Introduction to Sustainable Development. Earthscan Publishers, 416 pp.
Brown, L. 2009. Plan B 4.0. Norton Publishers, New York. (The entire book is available in pdf format: http://www.earthpolicy.org/images/uploads/book_files/pb4book.pdf)

References

1. Rogers, P.P., K. F. Jalal, and J.A. Boyd. 2007. An Introduction to Sustainable Development. Earthscan Publishers, 416 pp.
2. Brown, L. 2009. Plan B 4.0. Norton Publishers, New York. (The entire book is available in pdf format: http://www.earthpolicy.org/images/uploads/book_files/pb4book.pdf)

Weekly Teaching Plan

Week 1
Introduction to Sustainability; basic concepts

Week 2
Basic concepts; Human Population – Past and Future trends

Week 3
Ecosystems

Week 4
Extinctions and Tragedy of Commons

Week 5
Climate and Energy

Week 6
Climate and Energy

Week 7
Water Resources

Week 8
Water Resources and Agriculture

Week 9
Water Resources and Agriculture: Case Studies and Examples

Week 10
National Resources Accounting Environmental Economics and Policy Measuring Sustainability

Week 11
National Resources Accounting Environmental Economics and Policy Measuring Sustainability

Week 12
Systems interconnectivity among Primary Sustainability challenges

Week 13
Systems interconnectivity among Primary Sustainability challenges

Week 14
Sustainability Solutions: Some examples

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Sustainability, Natural Resources, Environmental Economics, Economic Policy.

GROUND WATER MANAGEMENT AND WATER QUALITY

(GEOLGE9)

Generic Elective - (GE)

Credits: 6, Theory (4), Practical (2)

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.

Suggested Readings:

Todd, D. K. (1980). Groundwater hydrology, 2ed. John Wiley. (p. 535).

Karanth, K.R. (1987). Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.

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.
Suggested Readings:

Todd, D. K. (1980). Groundwater hydrology, 2ed. John Wiley. (p. 535).

Karanth K.R. (1987). Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.

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.

Suggested Readings:

Todd, D. K. (1980). Groundwater hydrology, 2ed. John Wiley. (p. 535).

Karanth K.R. (1987). Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.

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.

Suggested Readings:

Todd, D. K. (1980). Groundwater hydrology, 2ed. John Wiley. (p. 535).

Karanth, K.R.(1987). Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.

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 McGraw-Hill Pub. Co. Ltd.

Practicals

Preparation and interpretation of water level contour maps and depth to water level maps. Graphical representation of chemical quality data and water classification (Trilinear diagrams). Fundamental exercise on groundwater resources estimation. Basic fundamental exercises on aspects related to designing rainwater harvesting and artificial recharge structures.

Suggested readings:

Todd, D. K. (1980). Groundwater hydrology, 2ed. John Wiley. (p. 535).

Karanth, K.R. (1987). Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.

Additional Resources:

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

Shekhar Shashank. 2017. Darcy's law. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: https://epgp.inflibnet.ac.in/ahl.php?csrno=448

Shekhar Shashank. 2017. Assessment of groundwater quality. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: https://epgp.inflibnet.ac.in/ahl.php?csrno=448

Teaching plan

Week 1
Water science and its societal relevance, Hydrologic cycle and interaction of the surface and subsurface water, Vertical distribution of subsurface water.
Practical: Basic exercise based on depth to water level maps.

Week 2
Introduction to the concept of porosity and permeability, classification of rocks and sediments as aquifer, aquitard, aquiclude and aquifuge.
Practical: Exercise based on depth to water level map.

Week 3
Types of Aquifer, concept of the piezometric surface and water table.
Project/assignment based presentation by the students, evaluation and discussions on the same.
Practical: Basic exercise based on water table contour map.

Week 4
Aquifer parameters.
Project/assignment based presentation by the students, evaluation and discussions on the same.
Class Test/quiz - 1
Practical: Exercise based on water table contour map.

Week 5
Introduction to Darcy's law and the concept of: static water level, pumping water level, draw down, radius of influence, cone of depression, specific capacity etc.
Project/assignment based presentation by the students, evaluation and discussions on the same.
Practical: Exercise based on water table contour map.

Week 6
Introduction to: the basic concept of water balance and the groundwater resources estimation.
Project/assignment based presentation by the students, evaluation and discussions on the same.
Practical: Exercise based on water table contour map.

Week 7
Principles of the groundwater management.
Project/assignment based presentation by the students, evaluation and discussions on the same.
Practical: Exercise based on water table contour map.

Week 8
Rainwater harvesting and artificial recharge to groundwater.
Project/assignment based presentation by the students, evaluation and discussions on the same.
Class Test/quiz - 2
Practical: Fundamental exercise on groundwater resources estimation.

Week 9
Rainwater harvesting and artificial recharge to groundwater.
Project/assignment based presentation by the students, evaluation and discussions on the same.
Practical: Fundamental exercise on groundwater resources estimation.

Week 10
Watershed management as an integral part of groundwater management.
Project/assignment based presentation by the students, evaluation and discussions on the same.
Practical Basic fundamental exercises on aspects related to designing rainwater harvesting and artificial recharge structures.

Week 11
Introduction to the concept of water quality, contamination and pollution.
Project/assignment based presentation by the students, evaluation and discussions on the same
Practical: Basic fundamental exercises on aspects related to designing rainwater harvesting and artificial recharge structures.

Week 12
Water quality parameters: Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), organoleptic; physical; chemical; radioactive and bacteriological parameters.
Project/assignment based presentation by the students, evaluation and discussions on the same.
Class Test/quiz - 3
Practical: Basic fundamental exercises on aspects related to designing rainwater harvesting and artificial recharge structures.

Week 13
The criteria for portable and irrigation use and graphical representation of the water quality data.
Project/assignment based presentation by the students, evaluation and discussions on the same.

Practical: Practical exercise based on graphical representation of chemical quality data and water classification (Trilinear diagrams).

Week 14
The criteria for portable and irrigation use and graphical representation of the water quality data.
Project/assignment based presentation by the students, evaluation and discussions on the same.
Practical: Practical exercise based on graphical representation of chemical quality data and water classification (Trilinear diagrams).
Class Test/quiz - 4

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Water Science; groundwater; groundwater flow; water quality; water balance; groundwater management.

HISTORY OF THE EARTH

(GEOLGE10)
Generic Elective - (GE)
Credits: 6, Theory (4), Practical (2)

Course Objective (2-3)

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.

Suggested Reading:
Hazen, Robert (2012). The Story of Earth : The first 4.5 billion years, Penguin.

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.

Suggested Reading:
Hazen, Robert (2012). The story of Earth: The first 4.5 billion years. Penguin.

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.

Suggested Reading:
Knoll, A.H. Life on a young Planet. Princeton Science Library

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.

Practicals

1. Excercises on major palaeogeographical reconstruction with special reference to Indian subcontinent.
2. Plotting of Global Stratotype Section and Points on a world map
3. Distribution of Marine Rocks on world map in various geological time slices
4. Studying sea level changes through geological time

References

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

Weekly Teaching Plan

Week 1

Physical History of Earth
Origin of Planet Earth,

Week 2
Early evolution of Earth's Atmosphere.

Week 3
Origin of Oceans. Earliest supercontinent and history of its breakup.

Week 4
Basic concepts of plate Tectonics and Wilson Cycle.

Week 5
Chemical History of Earth

Week 6
Early differentiation of the Earth's layers. Mechanical and compositional layers of earth.

Week 7
Abundance of elements. Comparison of Earth's chemistry with other planets of our Solar System.

Week 8
Biological History of Earth

Week 9
Origin of life on Earth. Earliest record of life in Earth's rocks.

Week 10
Evolution from single cell to multicellular life. Ediacara Fauna and its significance.

Week 11
Evolution of skeletal organisms. A brief overview of Palaeozoic, Mesozoic and Cenozoic life.

Week 12
Evolution of continents and oceans

Week 13
Continental drift and sea floor spreading.

Week 14
History of Atlantic, Pacific and Indian Oceans. Separation of Gondwanaland

Practicals

1. Excercises on major palaeogeographical reconstruction with special reference to Indian subcontinent.
2. Plotting of Global Stratotype Section and points on a world map
3. Distribution of Marine Rocks on world map in various geological time slices
4. Studying sea level changes through geological time

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Geological Time, Paleoclimate, Fossils, supercontinent, evolution

PLANETARY GEOLOGY

(GEOLGE11)
Generic Elective - (GE)
Credits: 6, Theory (4), Practical (2)

Course Objective (2-3)

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.

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

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?

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

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

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

Unit 5
Saturn: Rings & Strange Moons, structure
Pluto
Exoplanets and search for earth like planets

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

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.

References

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

Weekly Teaching Plan

Week 1
Introduction to Planetary Geology, Planetary configuration and description

Week 2
The Big Bang & Early Solar System History

Week 3
Impact Craters: A Geologic Process and Markers of Time

Week 4
Meteorites: the building blocks of planets- Classification and types

Week 5
Asteroids

Week 6
Techniques in planetary science- Remote techniques

Week 7
The Moon: Formation & Evolution, Internal structure, composition, water on the moon

Week8
Venus: Earth's Twin?

Week 9
The early Earth and primary geochemical differentiation, the first billion years and emergence of life.

Week 10
The great oxidation event and search for life beyond earth

Week 11
Planetary surface and interior processes and their Atmosphere

Week 12
Mars- Results from the Curiosity Rover, Climatic Evolution & Prospects for Life

Week 13
Saturn: Rings & Strange Moons, structure

Week 14
Pluto and Exoplanets and search for earth like planets

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Craters. atmosphere, exoplanets, impact features, remote sensing.

SOILS: PAST AND PRESENT

(GEOLGE12)

Generic Elective - (GE) Credits: 6

Course Objective (2-3)

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.

Suggested Readings:
Birkeland, P.W. (1999). Soil and Geomorphology. Oxford University Press.
Retallack, G.J. (2001). Soils of the Past: An Introduction to Paleopedology, Oxford.
Prothero, D. R., & Schwab, F. (2004). Sedimentary Geology. Macmillan.

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.
Suggested Readings:
Birkeland, P.W. (1999). Soil and Geomorphology. Oxford University Press.
Retallack, G.J. (2001). Soils of the Past: An Introduction to Paleopedology, Oxford.
Prothero, D. R., & Schwab, F. (2004). Sedimentary Geology. Macmillan.

Unit 3

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

Suggested Readings:
Birkeland, P.W. (1999). Soil and Geomorphology. Oxford University Press.
Retallack, G.J. (2001). Soils of the Past: An Introduction to Paleopedology, Oxford.
Prothero, D. R., & Schwab, F. (2004). Sedimentary Geology. Macmillan.

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

Suggested Readings:
Birkeland, P.W. (1999). Soil and Geomorphology. Oxford University Press.
Retallack, G.J. (2001). Soils of the Past: An Introduction to Paleopedology, Oxford.
Prothero, D. R., & Schwab, F. (2004). Sedimentary Geology. Macmillan.

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.

Suggested Readings:
Birkeland, P.W. (1999). Soil and Geomorphology. Oxford University Press.
Retallack, G.J. (2001). Soils of the Past: An Introduction to Paleopedology, Oxford.
Prothero, D. R., & Schwab, F. (2004). Sedimentary Geology. Macmillan.

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, Oxford.

Practicals

1. Micromorphic detailing of the palaeosols- structure, horizonation, color, rhizocretions, pedogenic carbonate etc.

2. Particle size analysis and clay mineral analysis of the palaeosols

3. Micromorphological analysis- thin section preparation, description, and interpretation

4. Geochemical analysis- bulk geochemistry, molecular rations and weathering indices

5. Field trip to examine modern and fossil soils- field characterization and sampling procedures

References

1. Retallack, G.J. (2001) Soils of the Past: An Introduction to Paleopedology (2nd edition): Oxford, Blackwell Science, Ltd., 416 p.

2. Birkeland, P.W. (1999) Soil and Geomorphology. Oxford University Press (430 pp.).

3. Bullock, P., Fedoroff, N., Jongeroius, A., Stoops, G. & Tursina, T. (1985) Handbook of Soil Thin Section Description. Waine Research Publication, Wolverhampton (152 pp.).

Additional Resources:

1. Sheldon, N.D. & Tabor, N.J. (2009) Quantitative palaeoenvironmental and paleoclimatic reconstruction using paleosols. Earth-Science Reviews 95, 1–52.
2. Stoops, G. (2003) Guidelines for analysis and distribution of soil and regolith thin sections. Soil Sci. Soc. Am., Madison, Wisconsin, 184 pp.
3. Soil Survey Staff, (2006) Key to Soil Taxonomy, 10th ed. USDA Natural Resources Conservation Service, Washington D.C.(341 pp.)
4. Bhattacharyya T., Sarkar, D., Pal, D. K. (Eds.) Soil Survey Manual. NBSSLUP Publication No 146.

Weekly Teaching Plan

Week 1

Introduction to soils and soils forming processes and types of major soils.

Week 2

Concept of weathering related to physical, chemical and biological weathering. Physical weathering, loosening and particle size reduction; pressure release; thermal expansion; growth of foreign crystal.

Week 3

Chemical weathering: Oxidation; Carbonation; Hydrolysis; Hydration; Base Exchange; Chelation; Microbial weathering.

Week 4

Controlling factors of soil formation- parent material, climate, vegetation, topography, time.

Week 5
Modern soils and key pedofeatures: Soil structures; horizons; roots; Fe-Mn mottles and concretions; pedogenic carbonates

Week 6
General soil forming regimes: Gleization; podzolization; lessivage; ferrallitizatin; calcification; salinization.

Week 7
Introduction to soil taxonomy and palaeosol taxonomy.

Week 8
Thin section analysis of palaeosols, Geochemical attributes of soils and palaeosols.

Week 9
Stable isotope geochemistry: Carbon13 and Oxygen18 system for vegetation, estimation of palaeotemperature, and paleo-pCO2. Diagenetic overprinting in fossil soils: compaction; oxidation of organic matter; cementation; illitization

Week 10
Introduction to palaeopedology and palaeosols. Formation of soils/paleosols through time. Controlling factors of palaeosol formation.

Week11
Geological record of fossil soils- Precambrian palaeosols- evolution of palaeoatmospheric conditions

Week 12
Geological record of fossil soils- Palaeozoic paleosols- evolution of land animals and plants, coal, Permian-Triassic transition palaeosols and extinction events.

Week 13
Geological record of fossil soils- Mesozoic-Cenozoic palaeosols- fossil soils at K-T extinction event.

Week 14
Paleogene fossil soils at green house to ice house transition, evolution of Asian monsoon system.

Teaching Learning Process

Regular class lenctues, Assignment, Seminar, Quiz

Assessment Methods

Internal Assessment (Seminar and Assignment), Quiz, Examination

Keywords

Soil, Paleosol, Palaeopedology, Permo-Triassic, Pleistocene-Holocene

GEOTOURISM

(GEOLOGE13)

Generic Elective - (GE)

Credits: 6, Theory (4), Practical (2)

Course Objective (2-3)

This is designed as an applied course where student learns to combine and optimize the tourism potential of spectacular geological features.

Course Learning Outcomes

1. Distinguishing and identifying potential geological sites of tourist interest
2. Spectacular (e.g. geomorphic landforms, structures) as well as intrinsic sites (major time boundaries, fossil sites, LIP's, transgressions regressions etc)
3. Economic aspects and linking geospots with other tourist destinations in a theme

Unit 1

Tourism and its different forms and their interrelations.
Geotourism: definition, characteristics and international/national perspectives
Eco-tourism and Geo-tourism
Suggested Readings:
Global Geotourism perspectives, Dowling, R. K., & Newsome, D. (Eds) USA: Goodfellow Publishers Limited (2010).
Young C.Y. Ng. & Yunting Lu (2015). The Principles of Geotourism, Anze Chen, (Springer).
Geotourism, Dowling, R. K., & Newsome, D. (Eds) Elsevier Butterworth- Heinemann (2006)
Geoheritage and Geotourism- a European Perspective, Thomas A. Hose (Ed) Boydell Press Woodbridge, UK

Unit 2

Geology and Tourism
Geodiversity, geoheritage, geoconservation and their relationship to geotourism
Geotourism and cultural heritage
The application of geographical information systems in geotourism.

Suggested Readings
T.A. Hose (Ed.) (2016). Appreciating Physical Landscapes: Three Hundred Years of Geotourism, Geological Society Special Publication No. 417, London.
Thomas A. Hose (Ed.).Geoheritage and Geotourism- a European Perspective, Thomas A. Hose (Ed) Boydell Press Woodbridge, UK
Ross Dowling & David Newsome (Eds) (2018). Handbook on Geotourism, Edward Elgar Publishing.

Unit 3

Education as a key tenet of geotourism and Earth Science Education & Geotourism
Geoheritage and public geoliteracy: opportunities for effective geoscience education within geosites
Earth Science Museums and their role in promotion of Geotourism
Examples of Geotourist sites from- e.g. Glacier features, Ox-bow lakes, Deltas etc.

Suggested Readings:
Dowling, R. K., & Newsome, D. (Eds) (2010). Global Geotourism perspectives, USA: Goodfellow Publishers Limited.
Dowling, R. K., & Newsome, D. (Eds) (2006). Geotourism, Elsevier Butterworth- Heinemann (2006).

Unit 4

Geotourism, Society and Sustainability
Public–private partnership framework for sustainable geopark development
Geotourism—a focus on the urban environment including historical geotourism
Potential of Geotourism in Economic development of any region.
Role of Tourism sector in terms of world economy/ Indian economy
Role of Geotourism in Tourism industry with special reference to Indian scenario
Entrepreneurship and start-up.

Suggested Readings:
A monograph on National Geoheritage Monuments of India. Indian National Trust for Art and Cultural Heritage(INTACH) Natural Heritage Division, New Delhi (2016).
National Geological Monuments. Geological Survey of India, Kolkata, Special Publication No.6 1(2001)
Kale, V.S. (ed.) (2014). Landscapes and Landforms of India, Springer, Dordrecht.

Unit 5

Geotourism and geoparks
UNESCO Global Geoparks and Geoconservation
Geo site developed by Geological Survey of India

Suggested Readings:
History of Geoconservation, C. V. Burek and C.D. Prosser (Eds.) Special Publication 300, Geological Society of London (2008)
National Geological Monuments. Geological Survey of India, Kolkata, Special Publication No.6 1 (2001).

Practicals

Study of Geological Map of India
Plotting the established geosites, geoparks and geo monuments of India on map.
Plotting geosites, geoparks and geo monuments on map of World.
Detailed study of geosites of India-Locality, Approach, Geological importance and foot fall.
Five Case studies from India where geosites can be developed.

References

Young C.Y. Ng. & Yunting Lu (2015). The Principles of Geotourism, Anze Chen, (Springer).

Dowling, R. K., & Newsome, D. (Eds) (2006). Geotourism, Elsevier Butterworth- Heinemann.

Hose, T.A. (Ed.) Geoheritage and Geotourism- a European Perspective, Boydell Press Woodbridge, UK.

Hose, T.A. (Ed.) (2016). Appreciating Physical Landscapes: Three Hundred Years of Geotourism, Geological Society Special Publication No. 417, London.

Hose, T.A. (Ed.) (2016). Appreciating Physical Landscapes: Three Hundred Years of Geotourism, Geological Society Special Publication No. 417, London.

Dowling, R. & Newsome, D. (Eds) (2018). Handbook on Geotourism, Edward Elgar Publishing.

Dowling, R. K., & Newsome, D. (Eds) (2010). Global Geotourism perspectives) USA: Goodfellow Publishers Limited.

A monograph on National Geoheritage Monuments of India. Indian National Trust for Art and Cultural Heritage(INTACH) Natural Heritage Division, New Delhi (2016)

National Geological Monuments. Geological Survey of India, Kolkata, Special Publication No.61 (2001)

Kale, V.S. (2014). Landscapes and Landforms of India, Springer, Dordrecht.

Burek, C.V. & Prosser, C.D. (Eds.) (2008). History of Geoconservation Special Publication 300, Geological Society of London.

Weekly Teaching Plan

Week-1
Tourism and its different forms and their interrelations.

Week-2
Geotourism: definition, characteristics and international/national perspectives

Week-3
Eco-tourism and Geo-tourism

Week-4
Geology and Tourism, Geodiversity, geoheritage.

Week-5
Geo conservation and their relationship to geotourism.Geotourism and cultural heritage

Week-6
The application of geographical information systems in geotourism

Week-7
Education as a key tenet of geotourism and Earth Science Education & Geotourism

Week-8
Geoheritage and public geoliteracy: opportunities for effective geoscience education within geosites

Week-9
Earth Science Museums and their role in promotion of Geotourism.Examples of Geotourist sites from- e.g. Glacier features, Ox-bow lakes, Deltas etc.

Week-10
Geotourism, Society and Sustainability. Public–private partnership framework for sustainable geopark development.

Week-11

Geotourism—a focus on the urban environment including historical geotourism. Potential of Geotourism in Economic development of any region.

Week-12
Role of Tourism sector in terms of world economy/ Indian economy.
Role of Geotourism in Tourism industry with special reference to Indian scenario- Entrepreneurship and start-up.

Week-13
Geotourism and geoparks. UNESCO Global Geoparks and Geoconservation.

Week-14
Geo site developed by Geological Survey of India

Teaching Learning Process
Lectures, Practicals, Seminar, Tutorials, Assignments.

Assessment Methods
Tests, Quiz, Debates and Presentations.

Keywords
Geological features, geomorphology, nature tourism. Geoparks, natural museum.