

GEO-C101: MINERALOGY

(Theory: 4 credits & Practical: 2 credits)

Pre-requisites:

Basic (10+2) knowledge of chemistry and physics + good observational skills.

Course objectives:

Minerals are the fundamental blocks of all Earth's solid material and also that of the inner planets of our Solar system. Mineralogy is essential for the courses in igneous, sedimentary and metamorphic petrology, economic geology and for interpretation of geophysical data. This course in Mineralogy would help the students to understand distribution of minerals in different Earth's spheres, evaluate different processes of mineral formation, why some minerals are restricted to particular physic-chemical environments, identify and characterize the minerals based on their physical, crystal chemical and optical properties. The student will learn the basic principles behind the arrangement of atoms to form crystal structures, how these atoms are coordinated and bonded and how this is reflected in the external form, chemical composition, and physical properties of the crystals. The student will learn how to identify the most common minerals in hand specimen and, by using optical techniques, learn how to identify the common minerals in thin section. The course introduces the minerals, which are of economic significance. The course also introduces the student to sophisticated instruments used in deciphering mineral structure and chemistry.

Course contents:

Unit I: Introduction and Scope

Mineralogy and its scope
Classification of Minerals
Processes of Mineral formation

Unit II: Physical Properties of Minerals

Properties under light
Electrical properties
Magnetic properties
Radioactive properties

Unit III: Chemistry and Structure of Minerals

Chemistry: Basic properties of Elements
Chemical and Geochemical Classification of Elements
Solid solution
Exsolution
Polymorphism
Pseudomorphism

Pauling's Rules
Goldschmidt's Rules
Principles and use of EPMA in Mineralogical Studies
Principles and use of ICP-MS in Mineralogical Studies

Structure: Crystal systems, Space Lattice and Unit Cell
Silicate Structures
Principles and use of XRD in Mineralogical Studies

Unit IV: Optical Properties of Minerals

Basic introduction to wave propagation
Isotropy and Anisotropy of Minerals
Petrological Microscope
Optical indicatrices
Orthoscopic properties
Conoscopic properties

Unit V: Descriptive Mineralogy

Silicates
Oxides
Carbonates
Sulphides
Precious and Semi-precious stones

GEO-C105: Practical based on GEO-C101 (2 Credits)

- ❖ Study of Rock-forming minerals in Hand Specimen
- ❖ Study of Rock-forming minerals in Thin Section
- ❖ Conoscopic Observations of minerals
- ❖ Calculation of Mineral Chemical Formulae

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Field studies
5. Quizzes
6. Oral presentations
7. Mid-term examinations
8. End-term examinations
9. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Explain why different minerals have distinctly different structures
- 2) Explain distribution of elements in different structural sites of the minerals
- 3) Explain how the properties of chemical elements and their bonds determine the structure and composition of minerals
- 4) Demonstrate how the internal structure of minerals affects the external structure and physical properties of a minerals
- 5) Explain the mineralogical concepts of isomorphism, polymorphism, isostructuralism, solid solution and exsolution
- 6) Discuss which mineral identification method is appropriate for solving a mineralogical problem (e.g. polarizing microscope, x-ray diffraction, electron microprobe)
- 7) Recognize and describe the basic properties and chemistry of common rock-forming minerals
- 8) Identify minerals based on megascopic and microscopic observations
- 9) Able to calculate mineral formulae based on chemistry

Prescribed and Reference Books

Principles of Crystal Chemistry: E. Cartmell (Crystal Chemistry)

*Crystallography: Walter Borchardt-Ott (X-Ray Diffraction and Crystal Chemistry)

An introduction to Mineralogy for Geologists: Phillips & Phillips (Crystallography, Crystal Chemistry & Silicate Structures)

Principles of Mineralogy: Blackburn & Denner (X-Ray Crystallography & Descriptive Mineralogy)

*An Introduction to the Rock-Forming Minerals: W.A. Deer, R.A. Howie & J. Zussman (Descriptive Mineralogy)

*Manual of Mineralogy: C.Klein & C.S. Hurlbut (Prescribed Text Book)

*Rutley's Elements of Mineralogy: C.D. Gribble (An Elementary text Book)

Dana's New Mineralogy: Gaines, Skinner, Foord, Mason, Rosenzweig (Descriptive Mineralogy)

Mineralogy: Berry Mason & Dietrich (Descriptive Mineralogy)

Optical Mineralogy: Phillips & Griffen (Optical Mineralogy)

Rock & Minerals: Dougal Dixon (Good Photographs)

The Illustrated Encyclopedia of Minerals and Rocks: J. Kourimsky (Good Photographs)

Rocks and Minerals: Chris Pellant (Good Photographs)

Rocks and Minerals: Basil Booth (Good Photographs)

Heavy Minerals in Colour: Mange & Maurer (Good Photographs & brief description of Heavy Minerals)

Minerals: G.W. Robinson (Good Photographs of Minerals)

Rock-forming Minerals in Thin Section: H. Pichler & C. Schmitt-Riegraf (Thin Section Photographs)

Lecture hand-outs

Research papers

- **Recommended Books**

GEO-C102: STRUCTURAL GEOLOGY and GEOTECTONICS

(Theory: 4 credits & Practical: 2 credits)

Pre-requisites:

Basic (10+2) knowledge of minerals and rocks. The course has field tour on holidays, wherein student has to work independently. The field tour is a compulsory component of the course.

Course objectives:

- to interpret the data and identify the structural features
- to train the students in identification of structural features, measurement of field data from the structures in the field, plotting and interpreting them
- to train the students in understanding the mechanics of deformations
- Measurement of various orientation data from the structures, plotting them in suitable diagrams and make a quantitative analysis
- to develop the writing skills based on research pattern/report writing which is useful in research institutes, Government organizations and private organizations
- to develop the skills of individual student so that he/she will be competent enough to get job in this field of specialization.

Course contents:

General Information about the Curriculum: This course looks at how one can recognize the structures, how rocks deform and use structures within the rocks to evaluate about the tectonic environment. Students will be introduced to techniques of collecting the field data and interpreting the structural data and plot it on a map. It will help students understand what has happened to the region since its formation. It will help students understand how part of the earth responded to the different types of forces

- **Unit I :- Stress-strain analysis-** behavior of rocks under stress, their significance, crack linkage **Folds:** Morphology, geometry, various types of folds; processes of folding, identification of folds in the field. Strain distribution in folds and its significance; strain within buckled layer, similar fold and shear fold, kink bands, chevron folds and conjugate fold. **Faults:** Faults, its nomenclature, types of faults, processes of faulting, identification of faults in the field. Fault reactivation and its importance, fold-thrust belt and structural evolution, Mechanics of faulting and folding, **rock fabrics**-origin, significance, metamorphic tectonites, petrofabrics at microscopic level use of Universal stage, stereographic and equal area projections.
- **Unit II :- Linear structures – Joints-** Tectonic and non-tectonic joints, columnar and release joints, joint initiation and its mechanics; **rock Cleavages**-axial plane cleavages, their significance, mechanics of rock cleavages, **Foliations and**

lineations primary and secondary-lineaments their kinematic significance; boudinage-types and significance; **Shear Zones:** types of shear zones; brittle-ductile and ductile structures in shear zones and their kinematic significance, shear zone rocks-mylonite, breccias, etc; Planar and linear fabrics in deformed rocks-origin and importance.

- **Unit III :- Continents & Oceans:** features & origin. Wilson cycle, **Geotectonics:** Concept of plate, types of plates, **Plate driving forces, Regional tectonic features:** ridges, arcs and subduction zone with special reference to Indian examples, hot spots; **Plate collision:** types, products; Tectonics of India with special reference to Himalaya plate convergence and Indian continental deformation; structures at macroscopic level; Deformation pattern and magma association and associated economically important deposits
- **Unit IV :- Structural and Tectonic Features of Deccan Trap:** General features of Deccan Trap, Structures in CDVP, Structures in SEDVP, Structures along SEDVP-EDC, contact-geometry of strike-slip and thrust tectonics along SEDVP-EDC

GEO-C106: Practical based on GEO-C102

Importance of contour diagrams, investigation and interpretation of geological maps; significance of structures in engineering geology; Stereographic analysis of structural data; Structural problems related to borehole data; stress-strain analyses, strain ellipsoids and their significance; analysing deformations at microscopic level and mesoscopic level; identification and interpretation of deformations in Deccan Trap and Eastern Dharwar Craton.

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Field studies
5. Quizzes
6. Oral presentations
7. Mid-term examinations
8. End-term examinations
9. Dissertation

Course outcome:

Skills developed after completing the course

Students who earn minimum grade should be able to

- Interpret the field data and interpret structures and deformations properly
- Identify and describe the structures at macroscopic, mesoscopic and microscopic level using specific nomenclature
- Understand and describe geometric features formed in the naturally deformed rocks and interpret the stress that developed the structure(s)
- Portray 3D structures on map using different field data
- Work individually in the field and produce structural map of a region
- Explain the structural features of the region and from this explain the geological history of the region
- Develop writing skills in writing home assignment, report etc which is useful in research institutes/govt. organisations/pvt organizations
- Understand the methodology of carrying out scientific research in the field of structural geology and geotectonics
- Present his/her research findings in the seminars/conferences etc. or publish the research papers at national and international level

• The course will also help student develop

- Critical thinking
- Writing skills
- Capacity to work independently
- Communication skills
- Plan the field and research work
- Self confidence

Prescribed and Reference Books

- ✓ An Introduction to Structural Geology – Geological Society of India
- ✓ Badgley, P.C. (1965): - Structure and Tectonics
- ✓ Bayly, B.(1992): - Mechanics in Structural Geology
- ✓ Condie, K.C. (1989) Plate Tectonics and Crustal Evolution, 3rd Ed.,
- ✓ Davis, G.R. (1984): - Structural Geology of Rocks and Region
- ✓ Davis, G.H. & Reynolds, S.J. 1996. Structural Geology of Rocks and Regions, Wiley (available at Unibooks)
- ✓ Developments, Pergamon Press.
- ✓ Fossen, H. 2010. Structural Geology, Cambridge (highly recommended)
- ✓ Gass, I.G. (1982) Understanding the Earth, Artemis Press (Pvt) Ltd. U.K..Moores, Eldridge M. and Twiss, Robert J. (1995) Tectonics, Freeman and Company.
- ✓ Geology, John Wiley and Sons, New York.
- ✓ Geology, Vol. III (Application of continuum mechanics), Academic Press.
- ✓ Geology, Vol. I, Strain Analysis, Academic Press.
- ✓ Geology, Vol. II, Folds and Fractures, Academic Press.
- ✓ Ghosh, S.K. (1993) Structural Geology: Fundamental and Modern
- ✓ Hobbs, B.E., Means, W.D. and Williams, P.F. (1976) An outline of Structural
- ✓ Kaplay, R.D., Md.Babar, P.R.Wesanekar and T.Vijay Kumar. (2017). Geological Structures of SEDVP.
- ✓ Kearey Phillips and Vine, F.J. (1996) Global Tectonics, Blackwell Science, Oxford.
- ✓ Keary, P., Klepeis, K.A. and Vine, F.J. (2012) Global Tectonics. Third Edition (Reprint), Wiley-Blackwell, Wiley India Pvt. Ltd.
- ✓ Keary, P and Vine, F.J. (1990); - Global Tectonics
- ✓ Marshak, S. and Mitra, G. (1988) Basic methods of Structural Geology,
- ✓ McClay, K., 1997. Mapping of Geological Structures, Open University Press – pretty hard to find, but a great little book
- ✓ Microtectonics. Second Edition. Springer. Berlin, (2005). Passchier, C.W., Trouw, R.A.J.
- ✓ Mineral Fish: their morphological classification, usefulness as shear sense indicators and genesis. S. Mukherjee
- ✓ Moors, E. and Taiss, R.J. (1995) Tectonics Pergamon, Oxford Press.
- ✓ Moores, E and Twiss, R.J. (1995) Tectonics. Freeman.
- ✓ Patwardhan, A.M. (1999) The Dynamic Earth System, Prentice-Hall, New Delhi
- ✓ Price, N.J. and Cosgrove, J.W. (1990): - Analysis of Geological Structures
- ✓ Prentice-Hall, New Jersey.
- ✓ Ramsay, J.G. (1967) Folding and fracturing of rocks, McGraw Hill.
- ✓ Ramsay, J.G. and Huber, M.I. (1983) Techniques of Modern Structural
- ✓ Ramsay, J.G. and Huber, M.I. (1987) Techniques of Modern Structural
- ✓ Ramsay, S.G. (1967): - Folding and Fracturing of Rocks
- ✓ Ramsay, J.G. and Huber, M.I. (2000) Techniques of Modern Structural
- ✓ Storetvedt, K.N. (1997) Our Evolving Planet: Earths History in New
- ✓ Tectonites, McGraw Hill.
- ✓ Tectonics and Structural Geology: Indian Context by Soumyajit Mukherjee, Springer, 2018
- ✓ Turner, F.J. and Weiss, L.E. (1963) Structural analysis of Metamorphic
- ✓ Windley, B.F. (1977) The Evolving Continents, John Wiley and Sons, New York.

- ✓ Valdiya, K.S. (1984) Aspects of Tectonics -Focus on south central Asia, Tata McGraw- Hill.
- ✓ Valdiya, K.S. (1998): - Dynamic Himalaya

Research Journals for further reading

- Current Science
- *Earth Science & Climatic Change*
- Geological Magazine
- Geological Society of London
- *Geological Society Open Journal of Geology*
- *Geology*
- Geology & Geoscience
- Geophysics Research Letter
- *GeoScience World*
- Gondwana Research
- *International Journal of Geology, Earth & Environmental Sciences*
- Journal of Earth System Science
- *Journal of Geological Research — an Open Access Journal*
- *Journal of the Geological Society*
- Marine Petroleum Geology
- Natural Hazard Earth System Science
- Pure Applied Geophysics
- Saudi Arabian Journal of Science & Technology
- Structural Geology
- Tectonic Geomorphology
- The J. Ind. Geophys. Union
- *The Journal of Geology*

GEO-C103: PALAEOLOGY

(Theory: 2 credits & Practical: 1 credit)

Pre-requisites:

Basic (10+2) knowledge of biology.

Course objectives:

- Study of paleontology with reference to animal and plant evolution.
- Application of micropaleontology in oil industries.
- To develop the writing skills based on research pattern/report writing which is useful in research institutes/govt. organizations/pvt. Organizations.
- To develop the skills of individual student so that he/she will be competent enough to get job in this field of specialization.

Course contents:

Unit I:

General classification of fossils
Evolution - evolutionary pattern based on fossil record
Stratigraphic range and distribution of invertebrate, vertebrate and plant fossils
Fossil record with special reference to India
Significance of marker fossils and fossil assemblages in stratigraphy

Unit II:

Definition and scope of Micropaleontology
Use of Micropaleontology in exploration of fossil fuels
Equipments for micropaleontological studies
Foraminifera and Ostracoda - their morphology, orientations, growth, reproduction, ecology and palaeoecology, classification, evolutionary trends and stratigraphic distribution

GEO-C107: Practical based on GEO-C102 (1 Credit)

- ❖ Megascopic identification and description of invertebrate and vertebrate fossil specimens in the laboratory
- ❖ Collection, identification and description of different fossils from the field.

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Field studies
5. Quizzes
6. Oral presentations
7. Mid-term examinations
8. End-term examinations
9. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Correlate different stratigraphic units based on fossil record
- 2) Classify and characterize different fossils
- 3) Better understand origin and evolution of life
- 4) Better understand the Palaeo-geography of India
- 5) Use microfossils in the exploration for fossil fuels
- 6) Identify fossils based on morphological observations

Prescribed and Reference Books

An introduction to fossils and minerals

By - Jon Erickson

Principles of palaeontology

By - Stanley Raup

Micropalaeontology: Principles and Applications by Pratul Kumar Sarswati and M.S. Srinivisan

GEO-C104: GEOCHEMISTRY

(Theory: 2 credits & Practical: 1 credit)

Pre-requisites:

Basic (10+2) knowledge of chemistry + good analytical skills.

Course objectives:

The science of Geochemistry deals with the primordial distribution of elements in different spheres, their migration one sphere to another sphere and the rules governing the distribution and migration of elements. Quantitative estimation of the distribution and migration of elements, in space and time, as the Earth evolved. Elements are the fundamental unit of all Earth's spheres and also that of the planets of our Solar system. Geochemistry is essential for the courses in igneous, sedimentary and metamorphic petrology, economic geology and for interpretation of geophysical data. This course in Geochemistry would help the students to understand origin of elements, cosmic abundance of elements, what makes Earth's chemical composition unique, primary distribution of elements in different Earth's spheres, evaluate different processes of element migration and how physic-chemical conditions control elemental migration. The course introduces stable and radioactive isotope geochemistry. The course also introduces the student to sophisticated instruments used in estimating major, trace and isotope geochemistry of Earth's materials.

Course contents:

Unit I: Introduction

Elements and the periodic table
Structure and composition of Universe, Solar system and Earth
Origin of elements
Cosmic abundance of elements
Primordial distribution of elements in Earth
Introduction to Stable and Radiogenic isotope geochemistry
Instruments in Geochemistry

Unit II: Geochemistry of Earth's spheres

Chemical differentiation of the Earth
Geochemistry of solid Earth (Core, Mantle and Crust)
Geochemistry of Atmosphere
Geochemistry of Hydrosphere
Geochemistry of Biosphere
Processes controlling Geochemistry of Earth's spheres

GEO-C108: Practical based on GEO-C104 (1 Credit)

- ❖ Graphical representation of geochemical data
- ❖ Mass balance equations and estimation of bulk composition of Earth
- ❖ Quantitative modeling of melting and crystallization

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Field studies
5. Quizzes
6. Oral presentations
7. Mid-term examinations
8. End-term examinations
9. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Explain the origin of elements
- 2) Explain distribution of elements in different spheres of the Earth
- 3) Explain how the atomic properties of elements and their bonds determine the structure and composition of Earth's spheres
- 4) Discuss the role of elements and their isotopes in evaluating Earth's processes
- 5) Explain the geochemical processes controlling elemental distribution
- 6) Quantitatively estimate element distribution

Prescribed and Reference Books

Principles of Geochemistry by **Brain Mason and Carleton B. Moore**

Geochemistry by **White, M.**

Essentials of Geochemistry (2nd Edition) by **Walther, J.**

Geochemistry Pathways and Processes (2nd Edition) by **McSween, H. Y., Richardson, S. M., and Uhle, M.**

Inorganic Geochemistry - Principles and Applications (3rd Edition) by **Faure, G.**

Introduction to Geochemistry - Principles and Applications by **Misra, K. C.**

Introduction to Geochemical Modeling by **Francis Albredade**

Inorganic Geochemistry by **Henderson**

GEO-E101: GEOSTATISTICS

(Theory: 3 credits & Practical: 1 credit)

Pre-requisites:

Basic (10+2) knowledge of Geology and Statistics.

Course objectives:

Basic objective of the course is to gain knowledge of available statistical methods and their limitations and to make student be able to analyse and prepare the geological data for applying geostatistical models. The main objective of geostatistics is characterization of geological phenomena, which are complex in their interrelationships and vast in their Spatial and Temporal extension. Statistics has huge importance in groundwater hydrology, petroleum reservoir characterization and modelling, and also in petrographical studies especially in sedimentary rocks. This course will teach the students how to statistically analyse and interpret the geological data to unravel the processes happened in the past.

Course contents:

Unit I: Introduction and Basic

Definition and scope of statistics, Limitations of statistics, Types of Data: Data collection, frequency distribution. Univariate analysis: Measures of Central tendency: Mean, Median, Mode, Merits and Demerits of Mean, Median and Mode; Definition, measures of dispersion, standard deviation, variance, coefficient of variation.

Unit II: Bivariate and Multivariate Analysis

Bi-variate analysis: Correlation and regression; Types of correlation, correlation coefficient, regression analysis; Probability: Basic concepts, Statistical hypothesis and tests; Type I and Type II errors, F, t, and Chi-square test: Multivariate analysis.

Unit III: Application of Statistics to Geology

Use of statistics in Petrology
Use of statistics in Geophysical-exploration and Mining Geology
Use of statistics in Hydrogeology
Use of statistics in Petroleum Geology

GEO-E106: Practical based on GEO-E101 (1 Credits)

- ❖ Study of Measure of Central Tendencies
- ❖ Study of Bi-variate analysis: Correlation and regression
- ❖ Study of different types of Errors and Tests
- ❖ Use of statistics in Geology

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Oral presentations
5. Mid-term examinations
6. End-term examinations
7. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Explain and Practice different measures of central tendencies, standard deviation and variance.
- 2) Explain and Practice Bi-variate analysis of data (Correlation and Regression)
- 3) Explain and Calculate the different types of Errors (Type I and Type II Error) and Tests (F- test, T- test etc.)
- 4) To use statistics in Geology

Prescribed and Reference Books

- Davis, J.C. Statistical data analysis in geology. John Wiley & Sons, 1986.
- Gupta S. C. Statistical Methods. S. Chand & Sons Publishers, 1997.
- Ross, S.M. Introduction to probability and statistics for engineers and scientists. Elsevier, 2004.
- Spiegel, M.R. Probability and Statistics, Schaums Outline Series, McGraw-Hill Intl., Singapore, Asian Student edition., 1982.
- Walpole, R.E. and Myers, R.H. Probability and statistics for engineers and scientists, Macmillan Publ. Co., 1989.
- Johnson, R.A. and Wichern, D.W. Applied multivariate statistical analysis, Prentice Hall Inc., New Jersey, 1982.

GEO-E102: CRYSTALLOGRAPHY

(Theory: 3 credits & Practical: 1 credit)

Pre-requisites:

Basic knowledge of solid state physics, geology and good observational and analytical skills.

Course objectives:

Crystals are abundant in nature, especially in rock formations as minerals. Crystals enable us to study the structure of matter at the atomic level. The basic objective of this course is to make the student to understand basic concepts of crystal structure of minerals including lattices, symmetries, point groups, and space groups and their interrelationship with physical properties will be explained. The theory and applications of X-ray diffraction (XRD) will be also explained.

Course contents:

Unit I:

- Historical development of crystallography and its importance in mineralogy
- Crystallography: crystal growth, external and internal symmetry, space group.
- Introduction to 32 classes of symmetry, description of holosymmetric class of various crystal systems, international system of crystallographic notation

Unit II:

- Different types of crystal projections – spherical and stereographic, and their uses
- Symmetry of internal structures – Bravais lattices; Twinning and twin laws, common types of twins and their examples in minerals
- Liquid crystals and their applications.
- Group theory and its application.
- Space lattice.
- Indexing of the diffraction pattern.

Unit III:

- XRD: powder and single crystal diffraction, reciprocal lattice and mathematical crystallography.
- Diffraction of X-ray by atoms and ideal crystal: Reciprocal lattice and diffraction experiments; single crystal-and powder methods;
- Crystal defects and chemistry: colour, cause and enhancement techniques, crystal field, molecular orbital and band theories.
- Electronic and vibrational spectroscopy methods.

GEO-E107: Practical based on GEO-E102 (1 Credits)

- ❖ Study of Classes of Symmetry
- ❖ Study of Unit Cell and Space Lattice

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Oral presentations
5. Mid-term examinations
6. End-term examinations
7. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Define concepts such as lattice, point and space groups
- 2) Recognize and describe the 32 classes of symmetry, description of holosymmetric class of various crystal systems, international system of crystallographic notation
- 3) Explain the Unit Cell and Space Lattice
- 4) Discuss which mineral identification method is appropriate for solving a mineralogical problem (e.g. x-ray diffraction)

Prescribed and Reference Books

Crystallography: Walter Borchardt-Ott (X-Ray Diffraction and Crystal Chemistry)

An introduction to Mineralogy for Geologists: Phillips & Phillips (Crystallography, Crystal Chemistry & Silicate Structures)

Principles of Mineralogy: Blackburn & Denner (X-Ray Crystallography & Descriptive Mineralogy)

Heavy Minerals in Colour: Mange & Maurer (Good Photographs & brief description of Heavy Minerals)

Crystallography and Mineralogy: Concepts and Methods: Ram S. Sharma and Anurag Sharma

GEO-E103: GEOCHEMISTRY FOR ENVIRONMENTAL SCIENCE

(Theory: 3 credits & Practical: 1 Credit)

Pre-requisites:

Basic knowledge of Geology and Chemistry.

Course objectives:

- Introduce Earth's processes and their products
- To introduce student about element abundances in different spheres of Earth.
- To introduce about distribution of elements in Earth and processes controlling the abundance and distribution.
- Geochemistry of Earth's surface.

Course contents:

Unit I:

Introduction to Periodic Table and Elements; Earth's Materials and their formation (Minerals, Rocks and Soils); Different spheres of the Earth and their interaction; Geological classification of elements, Thermodynamic classification of elements, Distribution of elements in crust, mantle and core. Introduction to Geodynamics and Geological time scale.

Unit II:

Processes controlling chemistry of Igneous, Sedimentary and Metamorphic rocks, chemical and biochemical processes on and near Earth's surface, geochemical evolution of solid Earth, Geochemical record for interpreting climate conditions.

Unit III:

Geochemistry of Marine, River and Groundwater; Water-rock interaction and chemistry of Groundwater and Surface water. Impact of Mining on the geochemistry of Groundwater and Surface water; Stable isotopes in Environmental geochemistry; Mixing theory and its application in Environmental Science.

GEO-E108: Practical based on GEO-E103 (1 Credit)

- ❖ Graphical representation of geochemical data
- ❖ Mass balance equations and estimation of pollutants from multiple sources
- ❖ Mixing equations

Mode of Assessment:

1. Tutorial examinations

2. Home Assignments
3. Seminars
4. Oral presentations
5. Mid-term examinations
6. End-term examinations
7. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Understand basic geological processes and their products
- 2) Comprehend interaction between different Earth spheres
- 3) Explain abundance and distribution of elements in different spheres of Earth.
- 4) Explain use of elements in understanding Earth's surface processes.
- 5) Explain how elements reflect past processes happened on the Earth.
- 6) Explain Processes controlling chemistry of Earth's materials.

Prescribed and Reference Books

- **Earth Materials** by Cornelis Klein and Anthony Philpotts
- **Using geochemical data: Evaluation, Presentation, Interpretation** by Hugh R Rollinson.
- **Principles of Geochemistry** by Brian Mason.
- **Geochemistry, Groundwater and Pollution** by C. A. J. Appelo
- **Textbook of Geochemistry** by Shardendu Kislaya
- **Groundwater Geochemistry** by J. Merkel Broder

GEO-E104: BASIC GEOLOGY

(Theory: 3 credits & Practical: 1 credit)

Pre-requisites:

Basic knowledge of Geology and Chemistry.

Course objectives:

- Introduce Earth's processes and their products
- To introduce student about element abundances in different spheres of Earth.
- To introduce about distribution of elements in Earth and processes controlling abundance and distribution.
- Geochemical exploration technique, path-finding elements to ore.

Course contents:

Unit I:

Introduction to geology, Geology as a fundamental science; branches of geology and relationships with other branches of science, weathering agents, Introduction to geomorphology Folds, faults, unconformities, joints and their classification, Geological time scale, Earth System: Lithosphere, Hydrosphere, Cryosphere and Atmosphere and their interactions

Unit II:

Mineralogy: Mineral - its definition and mode of occurrence, physical properties of minerals like form, colour, lustre, streak, cleavage, fracture, hardness and specific gravity, Physical characters and chemical composition of different rock forming minerals.

Unit III:

Petrology: Rock – its definition; classification and distinguishing characteristics of Igneous, Sedimentary and Metamorphic rocks; forms of Igneous rocks, elementary ideas regarding formation; Texture and structure of Igneous, Sedimentary and Metamorphic rocks; Brief petrographic description and occurrences different rocks :

GEO-E109: Practical based on GEO-E104 (2 Credits)

- ❖ Study of Rock-forming minerals in Hand Specimen
- ❖ Study of Rock-forming minerals in Thin Section
- ❖ Study of Rocks in Hand Specimen
- ❖ Study of Rocks in Thin Section

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Oral presentations
5. Mid-term examinations
6. End-term examinations
7. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Understand basic geological processes and their products
- 2) Comprehend interaction between different Earth spheres
- 3) Explain fundamental concepts of mineralogy and petrology

Prescribed and Reference Books

- **Earth Materials by Cornelis Klein and Anthony Philpotts**
- **The Earth: Press and Seiver**
- **Blue Planet: Skinner and Porter**
- **Physical Geology: Arthur Holmes**
- **A Text Book of Geology: P.K. Mukherjee**
- **Engineering Geology: Purbin Singh**
- **Earth Materials: Klein and Philpotts**
- **Principles of Petrology by Tyrrell**
- **Elements of Mineralogy by Read & Rutley's**

GEO-E105: GEOLOGY OF INDIA

(Theory: 3 credits & Practical: 1 credit)

Pre-requisites:

Basic scientific thinking and geology terminology.

Course objectives:

- To understand the principles and concept of Stratigraphy.
- To understand the geology of India, train the students in identification of beds, formations and other stratigraphic units
- To train the students to identify and correlate different geologic formations.

Course contents:

Unit I: Geological time scale and Sequence stratigraphy

Geological time scale;
Concepts of Sequence stratigraphy
Concept of lithofacies and biofacies
Stratigraphic correlation
Lithostratigraphy, biostratigraphy, chronostratigraphy and
magnetostratigraphy

Unit II: Geology of India: Precambrian

Basement problem
Classification and correlation of Precambrian crystalline rocks of India
Structure and Composition of Archaean crust
Archaean-Proterozoic boundary problem
Proterozoic Mobile belts
Main Proterozoic sedimentary and volcano sedimentary successions in India.

Unit III: Geology of India: Phanerozoic

Gondwana Supergroup
Mesozoic of Peninsular India
Deccan Basalt
Boundary problems: Permo-Triassic, K-T
Tertiary basins of India
Himalayas
Main Quaternary sediments in Peninsular India

GEO-E110: Practical based on GEO-E105 (1 Credit)

- ❖ Preparation of Stratigraphic correlation maps with the help of field data
- ❖ Preparation and study of geological map on the basis of geological formations
- ❖ Identification and preparation of geological maps with the help of field surveys

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Field studies
5. Quizzes
6. Oral presentations
7. Mid-term examinations
8. End-term examinations
9. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Correlate different stratigraphic units
- 2) Prepare a geological map
- 3) Better understand origin and evolution of Indian subcontinent as a geologic entity

Prescribed and Reference Books

The Making of India: Geodynamic Evolution

By – K. S. Valdiya

Geology of India: Volume 1 and Volume 2

By – M. Ramakrishnan and R. Vaidyanathan

GEO-OE101: EARTH MATERIALS

(Theory: 2 credits)

Pre-requisites:

Basic scientific thinking and basic (10+2) knowledge of chemistry, physics and biology..

Course objectives:

- To introduce student to what makes the planet Earth.
- Introduce Materials of the solid Earth
- Earth Materials and Human Health

Course contents:

Unit I: Elements and Minerals

Origin of Elements
Origin of Minerals
Physical properties of Minerals
Crystal Chemistry of Minerals
Some important rock- and ore-forming minerals
Minerals and Human Health

Unit II: Minerals and Rocks

Earth's structure
Mineralogy of Core, Mantle and Crust
Igneous rocks
Sedimentary rocks
Metamorphic rocks
Rock cycle

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Field studies
5. Quizzes
6. Oral presentations
7. Mid-term examinations
8. End-term examinations
9. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Define mineral and rock
- 2) Distinguish minerals and rocks
- 3) Correlate minerals and human health

Prescribed Book

Earth Materials by Cornelis Klein and Anthony Philpotts

GEO-OE101: ORIGIN AND EVOLUTION OF LIFE

(Theory: 2 credits)

Pre-requisites:

Basic knowledge of Geology and Biology.

Course objectives:

- Introduce basic geological concepts
- Introduce students with Fossils.
- To introduce student to origin and evolution of life on the earth.

Course contents:

Unit I:

Earth's Materials and their formation (Minerals, Rocks and Soils); Different spheres of the Earth and their interaction; Geological time scale. Origin of life; Evolution of life through time; Biostratigraphy.

Unit II:

Definition and scope of paleobiology, process of fossilization, preservation potential of organisms. Elementary ideas about origin of life, evolution and fossil record. Systematic classification of organisms – their characters, environmental factors, fossil fuels.

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Oral presentations
5. Mid-term examinations
6. End-term examinations
7. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Understand basic geological processes and their products
- 2) Comprehend interaction between different Earth spheres
- 3) Explain formation and preservation of fossils.
- 4) Explain evolution of life on the Earth with respect to geological time scale.

Prescribed and Reference Books

- **Earth Materials** by Cornelis Klein and Anthony Philpotts
- **Palaeontology (palaeobiology): Evolution and animal distribution.** by P.C. Jain & M.S. Anantharaman.

GEO-C201: IGNEOUS PETROLOGY

(Theory: 4 credits & Practical: 2 credits)

Pre-requisites:

Basic (10+2) knowledge of chemistry and physics + completion of courses GEO-C101 (Mineralogy) and GEO-C104 (Geochemistry).

Course objectives:

Igneous rocks are formed by crystallization of magmas derived from mantle and crust consequently they are the windows to deep Earth composition, structure and processes. Igneous rocks are also significant to understand planetary differentiation. Study of igneous rocks allows us to evaluate mantle-crust differentiation and interactions in space and time. Igneous rocks are fundamental to our understanding of vertical and horizontal tectonics of planet Earth. Volatiles exhaled from the magmas are the building blocks of Earth's primitive atmosphere and hydrosphere and eventually responsible for the origin of life. Finally, igneous rocks are abodes for many large-scale ore deposits. This course in Igneous petrology would help the students to understand origin of magmas in crust and mantle, evaluate different processes of magma generation, role of temperature, pressure, depth and volatiles on magma composition, application of thermodynamics in understanding igneous rocks, evaluate the role of geochemistry in deciphering magma generation and evolution, correlate magma compositions with plate boundaries, identify and characterize the igneous rocks based on their physical and textural characteristics.

Course contents:

Unit I: Igneous Petrology and its scope

From Planetary evolution to the evolution of Lithosphere, Hydrosphere and biosphere
Major Structural Units of the Earth
Pressure Distribution within the Earth
Temperature Distribution within the Earth
Heat Sources for Magma Generation
Physical Properties of the Magma
Cooling/Crystallization of Magmas and Igneous Textures
Classification Igneous Rocks

Unit II: Magma Generation and Evolution

Sites of Magma Generation
Petrology and Geochemistry of Mantle
Partial Melting
Primary Melts
Magmatic differentiation, Zone melting, Contamination, Mixing of magmas
Magmas and Tectonic Environments

Role of Geochemistry in Igneous Petrogenesis

Unit III: Phase Equilibria

Gibb's and Mineralogical Phase Rule
One component system
Two component system
Three component system
Four component system
Role of Volatiles on Phase Equilibria

Unit IV: Petrogenetic Suites and Associations

Komatiites
Basalts
Anorthosites
Layered Complexes
Ophiolites
Lamprophyres, Lamproites, Kimberlites, Carbonatites and Alkaline Rocks
Andesites and Boninites
Granites

GEO-C205: Practical based on GEO-C201 (2 Credits)

Study of Igneous Rocks in Hand Specimen
Study of Igneous Rocks in Thin Section
Binary and Ternary Variation Plots
Tectonic discrimination plots
Rare Earth Element and Incompatible Element Normalized Plots

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Field studies
5. Quizzes
6. Oral presentations
7. Mid-term examinations
8. End-term examinations
9. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Explain generation of different mantle reservoirs
- 2) Explain origin and differentiation of magmas
- 3) Apply phase equilibria to the genesis of igneous rocks
- 4) Utilize geochemistry in understating igneous processes
- 5) Discriminate present- and palaeo-tectonic environments of igneous rocks
- 6) Describe crust-mantle differentiation in space and time
- 7) Decipher relationship between petrogenesis and oreogenesis
- 8) Identify and characterize igneous rocks based on megascopic and microscopic observations
- 9) Graphically represent geochemical variations in magmas

Prescribed and Reference Books

1. **Principles of Igneous & Metamorphic Petrology** by **A. R. Philpotts** (*physical properties of Magma*)
2. **Igneous Petrology** by **McBirney** (*Textures & Rocks*)
3. **Igneous Petrology** by **Anthony Hall** (*Phase Equilibria*)
4. **Igneous and Metamorphic Petrology** by **Best** (*Rock Associations*)
5. **Igneous Petrology** by **D. S. Barker** (*Good general text book*)
6. **Igneous Petrogenesis and Global Tectonic Environments** by **Marjorie Wilson** (*Advanced Text on rock associations and tectonic environments*)
7. **Principles of Igneous Petrology** by **Maaloe** (*Good Theoretical text*)
8. **Petrology of Igneous Rocks** by **Hatch, Wells and Wells** (*Good introductory book*)
9. **Petrology of Igneous, Sedimentary and Metamorphic Rocks** by **Ehlers and Blatt** (*Good introductory book*)
10. **An Evolution of Igneous Rocks** by **N. L. Bowen** (*Classical text based on Experimental Petrology*)
11. **Petrology** by **Nockolds, Knox and Chinner** (*Classic introductory book*)
12. **Petrology** by **Raymond** (*Good introductory book*)
13. **The Principles of Petrology** by **G. W. Tyrrell** (*Basic introductory book*)
14. **Phase Diagrams** by **A. R. Morse** (*Good introductory book on phase equilibria*)
15. **Igneous Rocks** by **Gupta** (*With Indian examples*)
16. **Atlas Igneous Rocks and their Textures** by **McKenzie, Donaldson and Guilford** (*Excellent book on texture illustrations*)
17. **Petrography** by **William, Turner and Gilbert** (*Good introductory book on petrography*)
18. **Igneous and Metamorphic rocks under Microscope** by **Shelly** (*Good introductory book on petrography*)
19. **Introduction to Geochemical Modeling** by **Francis Albredade** (*Advanced book on geochemical modeling*)
20. **Inorganic Geochemistry** by **Henderson** (*Good introductory book on Geochemistry principles*)
21. **Principles of Geochemistry** by **G. Faure** (*Advanced book on Geochemistry principles*)

GEO-C202: Thermodynamics and Metamorphic Petrology

(Theory: 4 credits & Practical: 2 credits)

Pre-requisites:

Basic (10+2) knowledge of chemistry and physics + completion of courses GEO-C101 (Mineralogy) and GEO-C104 (Geochemistry).

Course objectives:

Metamorphic rocks are formed by pressure-temperature changes in the deep Earth consequently they are the windows to deep Earth composition, structure and processes. Metamorphic rocks are significant to understand crustal differentiation. Study of metamorphic rocks allows us to evaluate crust differentiation in space and time. Metamorphic rocks are fundamental to our understanding of vertical and horizontal tectonics of planet Earth. Volatiles consumed and released during formation of metamorphic rocks are very significant for the continuation of plate tectonics and subduction zone magmatism and formation of many ore deposits. Metamorphism is the fundamental process of altering earlier minerals and formation of new minerals stable in the changed physico-chemical conditions.

Course contents:

Unit I: Thermodynamics

System, Phase, Component and Phase Rule
Enthalpy, Entropy and Gibb's Free Energy
1st, 2nd and 3rd Laws of Thermodynamics
Reaction kinetics
Clausius - Clapeyron Equation and Calculation of Reaction Boundaries
Geothermobarometry
P-T-t Paths

Unit II: Introduction to Metamorphism

Metamorphism as a process of Earth's differentiation
Metamorphic processes
Role of P/T conditions and fluids in metamorphism
Deformation associated with metamorphism
Migmatites and partial melting,
Metamorphic structures and textures

Unit III: Metamorphic rocks: Grades, Zones and Facies

Types of metamorphism and their products
Metamorphic grades
Metamorphic zones

Metamorphic facies concept
Experimental studies on metamorphic reactions
Characteristics of important metamorphic reactions

Unit IV: Plate tectonics and Metamorphic rocks

Zeolite- and lawsonite-bearing rocks
Greenstones
Amphibolites
Granulites
Glucophane schists
Eclogites
Paired metamorphic belts
Metamorphic rocks in space and time

GEO-C206: Practical based on GEO-C202 (2 Credits)

Study of Metamorphic Rocks in Hand Specimen
Study of Metamorphic Rocks in Thin Section
AKF, ACF and AFM projections
Estimation of P-T conditions based on coexisting minerals

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Field studies
5. Quizzes
6. Oral presentations
7. Mid-term examinations
8. End-term examinations
9. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Apply principles of Thermodynamics to metamorphic processes
- 2) Explain elemental diffusion and formation of new minerals
- 3) Explain differentiation of continental crust
- 4) Discriminate present- and palaeo-tectonic environments of metamorphic rocks
- 5) Identify and characterize metamorphic rocks based on megascopic and microscopic observations
- 6) Graphically represent mineralogical variations in metamorphic rocks

Prescribed and Reference Books

1. **Principles of Igneous & Metamorphic Petrology** by **A. R. Philpotts** (*Thermodynamics and Facies concept*)
2. **Principles of Igneous and Metamorphic Petrology** by **John Winter** (*Good discussion on all aspects of metamorphic rocks*)
3. **An Introduction to Metamorphic Petrology** by **Bruce W.D. Yardley**
4. **Paired Metamorphic Belts** by **Miyashiro**
5. **Igneous and Metamorphic Petrology** by **Best** (*Rock Associations*)
6. **Petrology of Igneous, Sedimentary and Metamorphic Rocks** by **Ehlers and Blatt** (*Good introductory book*)
7. **Petrology** by **Nockolds, Knox and Chinner** (*Classic introductory book*)
8. **Petrology** by **Raymond** (*Good introductory book*)
9. **The Principles of Petrology** by **G. W. Tyrrell** (*Basic introductory book*)
10. **Phase Diagrams** by **A. R. Morse** (*Good introductory book on phase equilibria*)
11. **Atlas Metamorphic Rocks and their Textures** by **McKenzie, Donaldson and Guilford** (*Excellent book on texture illustrations*)
12. **Petrography** by **William, Turner and Gilbert** (*Good introductory book on petrography*)
13. **Igneous and Metamorphic rocks under Microscope** by **Shelly** (*Good introductory book on petrography*)

GEO-C203: SEDIMENTARY PETROLOGY

(Theory: 2 credits & Practical: 1 credit)

Pre-requisites:

Basic geology terminology and courses GEO-C101 (Mineralogy).and GEO-C104 (Geochemistry)

Course objectives:

- To train the students in identification of beds, formations, sedimentary structures, measurement of field, plotting and interpreting them.
- To train the students to identify and correlate the formation.
- Measurement of various orientation data from the structures, plotting them in suitable diagrams and make a quantitative analysis
- To develop the writing skills based on research pattern/report writing which is useful in research institutes/govt. organizations/pvt. organizations
- To develop the skills of individual student so that he/she will be competent enough to get job in this field of specialization.

Course contents:

Unit I:

Classification of sedimentary rocks
Processes and products of sedimentation
 Detrital sediments
 Chemical precipitates
 Volcaniclastics sediments
Sedimentary structures and textures
Particle size of detrital rocks:
 Definition, measurement, size parameters
 grain size distribution and causal factors
 grain size distributions and environmental analysis
 Sphericity and roundness
 Packing and fabric
 Porosity and permeability

Unit II:

Depositional environments and the sedimentary products
Palaeocurrents and basin analysis
Basin shape, depth and sedimentation
Geochemistry of sediments and sedimentary rocks

Source and process control on composition of Sedimentary rocks
Plate tectonics and sedimentary rocks

GEO-C207: Practical based on GEO-C203 (1 Credit)

Study of Sedimentary Rocks in Hand Specimen
Study of Sedimentary Rocks in Thin Section
Grain size and grain shape analysis of sediments

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Field studies
5. Quizzes
6. Oral presentations
7. Mid-term examinations
8. End-term examinations
9. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Correlate different stratigraphic units
- 2) Evaluate sedimentary environments
- 3) Carry out Palaeocurrent analysis
- 4) Identify and distinguish different sedimentary rocks

Prescribed and Reference Books

Sedimentology and Stratigraphy

By - Gary Nichols

Principles of Sedimentology and Stratigraphy

By- Sam Boggs

Depositional Environments by Reinick and Singh

Sedimentary Rocks by Pettiohn, F,J.

GEO-C204: ENVIRONMENTAL GEOLOGY

(Theory: 2 credits & Practical: 1 credit)

Pre-requisites:

Basic (10+2) knowledge of geology, chemistry and physics

Course objectives:

- Introduce environmental perspective to the geology students
- Introduce geology as a tool in the control of environmental pollution
- Equip the student with knowledge for societal needs

Course contents:

Unit I: Introduction and Air Pollution

Introduction, Fundamental Concepts of Environmental Geology: Present is a key to the future, Concepts of Lithosphere, Hydrosphere and Atmosphere and their Physico-chemical characteristics, Ecology- its meaning and Scope, Ecosystem Concept, Energy Flow in Ecosystem, Food chain and Food web, Ecological pyramid.

Classification of Air Pollutants, Sources of Air Pollutants, Indoor Air Pollution, Air Pollution and Meteorology, Air Quality Monitoring, Consequences of Air Pollution- Acid Rain, Ozone Depletion, Green House Effect and Global Warming, Effects of Air Pollution on life.

Unit II: Water and Soil Pollution and Role of Geology in Pollution Control

Types of water pollutants- physical, chemical, biological, Classification of pollutants- Inorganic pollutants, organic pollutants, Biological pollutants, sediments, Oxygen demanding waste, Disease causing agents, Radioactive pollutants. Sources of water pollution- Point sources, Non point sources, Natural and Anthropogenic sources, Sewage and domestic waste, Industrial effluent, Agricultural discharges, Fertilizers, Pesticides, Detergents, Herbicides, Toxic metals, Thermal pollutants. Types of pollution- Groundwater pollution, Surface water pollution- Lake water pollution, River water pollution, Eutrophication, Marine pollution, Effect on life.

Definition, Composition of Soil, Soil formation, Soil profile, Types of Soils, Pedogenic processes, Texture of Soil, Soil pH, saline and alkaline Soil, Cation Exchange capacity, Soil pollution by- urban waste, agricultural practices, chemical and metallic pollutants, Industrial effluent, Detrimental effects on Soil, Integrated Pest Management.

Pollution Control for Air, Water and Soil- Decontamination Procedures and Methods, Remedial Measures and role of Geology, Solid, Liquid, Hazardous Waste Disposal and management, Geological solutions for environmental problems, Geological factors in selection of Sites for Disposal, Environmental Impact Assessment (EIA).

GEO-C208: Practical based on GEO-C204 (1 Credit)

Chemical analysis of Water
Chemical analysis of Soil

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Field studies
5. Quizzes
6. Oral presentations
7. Mid-term examinations
8. End-term examinations
9. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Understand Air, Water and Soil pollutants
- 2) Apply geological methods in pollution control
- 3) Select sites for geological disposal of pollutants
- 4) Analyze Air, Water and Soil samples for their chemistry

Prescribed and Reference Books

Environmental Geology

By - Carla W. Montgomery

Environmental Geology, Handbook of Field Methods and Case Studies

By - Klaus Knödel, Gerhard Lange and Hans-Jürgen Voigt

Environmental Geology

By- Valdiya K. S,

An Introduction to Environmental Pollution

By Sharma B. K.

Air Pollution

By Sharma B. K.

Fundamentals of Soil Science

By Henry D. Foth

Environmental pollution and control

By P. Aarne Vesilind

Environmental Pollution Monitoring and Control

By Shripad Moreshwar Khopkar

GEO-E201: COMPUTER APPLICATIONS IN GEOLOGY

(Theory: 3 credits & Practical: 1 credit)

Pre-requisites:

Basic knowledge of Geology and Computer + Basic Software.

Course objectives:

Application computers and software is inevitable in modern learning techniques. This course offers fundamental concepts in computer organization and growth, basic computer programming and software relevant to geology.

Course contents:

Unit I:

Computer organizations, architecture and peripherals, Types of computers; Computer generations, Concept of operating system, MS office – Word, Excel and Power point; Internet

Unit II:

Computer programmers useful for geoscientific studies: application of Surfer, Excel, etc.; Specific applications in Geological studies. Introduction to GIS.

Unit III:

Use of computers and software as tools in the areas of geological problem-solving, report-writing, and presentations; Windows-based software applications, including word-processing, spreadsheets. Graphing, image manipulation, drawing, presentations (MS-Excel, Power Point, Adobe Illustrator, CorelDraw, Photoshop). Database - definition, structure, and types; Geological database. Construction of geological maps and sections using Adobe Illustrator and Coreldraw. Elementary concepts on Knowledge Based Expert System, Decision Support System, Neural Network, Fuzzy Logic and Genetic Algorithm. Use of Software Packages in Geology.

GEO-E203: Practical based on GEO-E201 (1 Credits)

- Mastering MS Office
- Processing Large Data Sets
- Use of Adobe Illustrator and Corel Draw for geological maps and sections.

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Oral presentations
5. Mid-term examinations
6. End-term examinations
7. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Use MS Office in processing and presenting geological data
- 2) Prepare geological maps using Adobe Illustrator and CoralDraw
- 3) Process large amount of geological data
- 4) Apply ANN to evaluate geological data

Prescribed and Reference Books

- Fundamentals of Computer: V. Rajaraman, Prentice Hall of India, New Delhi, 2008
- Computer Application in the Earth Sciences: Daniel Merriam
- Computer Fundamentals: Pradeep K. Sinha, Preeti Sinha, BPB Publications, New Delhi

GEO-E105: INDIA AS AGEOLGIC ENTITY

(Theory: 3 credits & Practical: 1 credit)

Pre-requisites:

Basic scientific thinking and geology terminology.

Course objectives:

- To introduce the student to geotectonics
- Introduce the student to formation different geological domains in different times
- Application of geotectonics in the making of India

Course contents:

Unit I: Introduction to Geotectonics

Plates and Plate boundaries
How and where the oceans and continents are formed
How and where the oceans and continents are destroyed
How and where the oceans and continents are conserved
Horizontal *versus* Vertical tectonics
Concept of Supercontinentality

Unit II: Making of India: Precambrian times

Formation of Cratons
Formation of Mobile Belts
Formation of Proterozoic Basins
India's neighbours in the Precambrian

Unit III: Making of India: Phanerozoic times

Fragmentation of Gondwana and development of Phanerozoic rift basins
Marine transgressions and regressions and consequent sedimentary rocks
Mantle plume and Deccan Basalts
India-Asia Collision and origin of Himalayas
India today
The journey of India in space and time: (some speculations and some facts)

GEO-E202: Practical based on GEO-E204 (1 Credit)

❖ Yet to be designed

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Field studies
5. Quizzes
6. Oral presentations
7. Mid-term examinations
8. End-term examinations
9. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Understand the concepts of plate and plume tectonics
- 2) Apply plate and plume tectonics in understanding Indian geology
- 3) Appreciate the uniqueness of Indian subcontinent

Prescribed and Reference Books

The Making of India: Geodynamic Evolution

By – K. S. Valdiya

Geology of India: Volume 1 and Volume 2

By – M. Ramakrishnan and R. Vaidyanathan

Research Papers

GEO-OE201: EARTH SYSTEM SCIENCE

(Theory: 2 credits)

Pre-requisites:

Basic scientific thinking and basic (10+2) knowledge of chemistry, physics and biology.

Course objectives:

- To introduce student to what makes the planet Earth.
- Introduce composition and structure of the Earth
- Introduce system approach to understand planet Earth

Course contents:

Unit I: Universe, Solar System and Earth

General characteristics and origin of the Universe, Solar System and its planets
Earth as a planet: Holistic understanding of dynamic planet 'Earth' through
Astrophysics, Geology, Meteorology and Oceanography
Introduction to various branches of Earth Sciences
Earth: size, shape, internal structure and composition

Unit II: Lithosphere, Hydrosphere, Atmosphere and Biosphere

Lithosphere,
Hydrosphere
Atmosphere
Biosphere
Continental Drift and Plate Tectonics and their consequences

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Field studies
5. Quizzes
6. Oral presentations
7. Mid-term examinations
8. End-term examinations
9. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Understand origin of Earth
- 2) Understand Earth internal structure and composition
- 3) Understand different spheres of the Earth and their interaction
- 4) Explain the loci of Earthquakes and volcanism on the planet Earth

Prescribed Book

Earth Materials by Cornelis Klein and Anthony Philpotts

The Earth: Press and Seiver

Blue Planet: Skinner and Porter

Physical Geology: Arthur Holmes

GEO-OE202: GEOLOGY FOR CHEMISTS

(Theory: 2 credits)

Pre-requisites:

Basic knowledge of Geology and Chemistry.

Course objectives:

- Introduce Earth's processes and their products
- To introduce student about element abundances in different spheres of Earth.
- To introduce about distribution of elements in Earth and processes controlling abundance and distribution.
- Geochemical exploration technique, path-finding elements to ore.

Course contents:

Unit I:

Earth's Materials and their formation (Minerals, Rocks and Soils); Different spheres of the Earth and their interaction; Geological classification of elements, Thermodynamic classification of elements, Distribution of elements in crust, mantle and core. Introduction to Geodynamics and Geological time scale.

Unit II:

Processes controlling chemistry of Igneous, Sedimentary and Metamorphic rocks, chemical and biochemical processes on and near Earth's surface, geochemical exploration techniques, geochemical evolution of solid Earth, Geochemical record for interpreting climate conditions.

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Oral presentations
5. Mid-term examinations
6. End-term examinations
7. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Understand basic geological processes and their products
- 2) Comprehend interaction between different Earth spheres
- 3) Explain abundance and distribution of elements in different spheres of Earth.

- 4) Explain use of elements in exploration of ore bodies.
- 5) Explain how elements reflect past processes happened on earth.
- 6) Explain Processes controlling chemistry of Earth's materials.

Prescribed and Reference Books

- **Earth Materials** by Cornelis Klein and Anthony Philpotts
- **Using geochemical data: Evaluation, Presentation, Interpretation** by Hugh R Rollinson.
- **Principles of Geochemistry** by Brian Mason.

GEO-OE203: GEOLOGY FOR BIOLOGISTS

(Theory: 2 credits)

Pre-requisites:

Basic knowledge of Geology and Biology.

Course objectives:

- Introduce basic geological concepts
- Introduce students with Fossils.
- To introduce student to formation and evolution of life on the earth.
- To introduce with fossil fuels.

Course contents:

Unit I:

Earth's Materials and their formation (Minerals, Rocks and Soils); Different spheres of the Earth and their interaction; Geological time scale.

Unit II:

Definition and scope of paleobiology, process of fossilization, preservation potential of organisms. Elementary ideas about origin of life, evolution and fossil record. Systematic classification of organisms – their characters, environmental factors, fossil fuels. Minerals and Human Health

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Oral presentations
5. Mid-term examinations
6. End-term examinations
7. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Understand basic geological processes and their products
- 2) Comprehend interaction between different Earth spheres
- 3) Explain formation and preservation of fossils.
- 4) Explain evolution of life on the Earth with respect to geological time scale.

Prescribed and Reference Books

- **Earth Materials** by Cornelis Klein and Anthony Philpotts.
- **Palaeontology (palaeobiology): Evolution and animal distribution** by P.C. Jain & M.S. Anantharaman.

GEO-OE204: GEOLOGY FOR PHYSICISTS

(Theory: 2 credits)

Pre-requisites:

Basic knowledge of Geology and Physics.

Course objectives:

- Introduce Earth's processes and their products
- Introduce students with Geophysical methods.
- To introduce student to use of geophysical methods in understanding Earth.
- To use of geophysical methods in Ore and Groundwater prospecting.

Course contents:

Unit I:

Introduction to evolution of Universe and our planetary system; Earth's Materials and their formation (Minerals, Rocks and Soils); Different spheres of the Earth and their interaction; Introduction to Geodynamics and Geological time scale.

Unit II:

Application of fundamental laws of physics to Planet Earth. Basic physical properties of the Earth's material. Introduction to crystallography; Polymorphism and phase transformations; Introduction to Gravity, Electrical, Magnetic and Seismic methods of exploring planet Earth.

Mode of Assessment:

1. Tutorial examinations
2. Home Assignments
3. Seminars
4. Oral presentations
5. Mid-term examinations
6. End-term examinations
7. Dissertation

Course outcome:

At the completion of the course student would be able to

- 1) Understand basic geological processes and their products
- 2) Comprehend interaction between different Earth spheres
- 3) Apply laws of physics in understanding planet Earth.

Prescribed and Reference Books

- **Earth Materials** by Cornelis Klein and Anthony Philpotts
- **Howell, 1959, Introduction to Geophysics, McGraw Hill Book Co. New York.**
- **I.K. Kaul, S. Senugupta and A.K. Bhattacharya, 1990, General and Applied Geophysics (An introduction), Associate of, Geophysics.**
- **Telford, W.M., Geldart, L.P. Sheriff, R.E. and Keys, D.A. 1981, Applied Geophysics, Cambridge University Press, Cambridge.**
- **Edwin S. Robinson and Cahit Coruh, 1988. Basic Exploration Geophysics John Wiley & Sons, New York Toronto/ Brisbane/ Singapore.562 P.**