

St. Xavier's College (Autonomous),
Mumbai



Syllabus of the courses offered by the
Department of Geology
MSc Geology
(2013 onwards)



St. Xavier's College – Autonomous Mumbai

Syllabus for M.Sc. Semester I in Geology (June 2013 onwards)

Courses:

- M.S.Geo.1.01 - Mineralogy
- M.S.Geo.1.02 - Geochemistry I
- M.S.Geo.1.03 – Structural Geology
- M.S.Geo.1.04 – Igneous Petrology

M.Sc.-I Geology
Title: Mineralogy

Course: M.S.Geo.1.01

Learning Objectives:

Study of the groups of rock forming minerals with particular reference to their crystal structure, chemistry, solid solutions, stability conditions, classification, physical and optical properties, alteration products and paragenesis.

Number of lectures: 60

Unit I

(15 lectures)

Fe-Mg Group and Mica Group

Pyroxenes
Amphiboles
Olivines
Mica

Unit II

(15 lectures)

Feldspar Group and Feldspathoids

Potassic Feldspar
Plagioclase Feldspar
Feldspathoids

Unit III

(15 lectures)

Other Minerals 1

Calcite
Dolomite
Apatite
Clay minerals
Zeolite
Aluminosilicates (Sillimanite, Andalusite & Kyanite)

Unit IV

(15 lectures)

Other Minerals 2

Staurolite
Epidote
Cordierite
Scapolite
Spinel

Reference Books:

MINERALOGY

1. Berry, Mason & Dietrich, (1985) Mineralogy. CBS Publishers, New Delhi.
2. Deer W.A., Howie R.A. & Zussman J., (1985) An Introduction to the Rock-Forming Minerals. ELBS/Longman.
3. Deer W.A., Howie R.A. & Zussman J., Rock Forming Minerals, Vol. I – IV.

4. Ford, W. E. (1992) A Textbook of Mineralogy. Wiley Eastern Ltd., New Delhi.
5. Frye, K., (1974) Modern Mineralogy. Prentice-Hall Publishers.
6. Klein, Cornelis and Hulburt, Cornelius S., Jr. (1985) Manual of Mineralogy. John Wiley and Sons, Singapore.
7. Mason, Brian & Berry, L. G. (1968) Elements of Mineralogy. W.H. Freeman and Co., San Francisco
8. Perkins, Dexter (2002) Mineralogy, 2nd edition, Prentice Hall of India Pvt. Ltd., New Delhi.
9. Putnis, Andrew (1992) Introduction to Mineral Sciences. Cambridge University Press, U.K.

Practical Course:

Megascopic and microscopic identification of minerals. :

Olivine, Pyroxene, Amphibole, Mica, Feldspar, Feldspathoid, Garnets

M.Sc.-I Geology

Course: M.S.Geo.1.02

Title: Geochemistry I

Learning Objectives:

Number of lectures: 60

Unit I

(15 lectures)

Elements

Atomic structure, Formation, Abundances, Distribution in Earth, Geochemical classification of elements

Unit II

(15 lectures)

Geochemical Cycle

Geochemical cycle

Basic principles of various analytical techniques in geochemistry

Unit III

(15 lectures)

Radiogenic Isotopes

Radioactivity

Range of Isotopic Systems (Rb/Sr, Sm/Nd, Lu/Hf, UTh-Pb, K/Ar-40, Ar/³⁹Ar, U-Th/He and Fission Tracks)

Applications in Geology (to trace and reconstruct evolution)

Unit IV

(15 lectures)

Stable Isotopes

Fractionation

Range of Isotopic Systems (Oxygen, Hydrogen and Carbon)

Applications in Geology

Goldschmidt's stability series

Recommended Books:

1. Faure, Gunter (1998) Principals and Applications in Geochemistry. Prentice Hall International (U.K.) Ltd., London
2. Jones, P. Meurig (1987) Applied Mineralogy a quantitative approach. Graham and Trotman, U.K.
3. Mason, Brian & Moore, Carleton B. (1982) Principals of Geochemistry. John Wiley and Sons, Singapore.
4. Werk, Hans-Rudolf and Bulakh, Andrei (2004) Minerals their constitution and Origin. Cambridge University Press, U.K.
5. Willard, Merritt & Dean, Instrumental Methods of Analysis.
6. Rollinson, H., (1994) Using Geochemical Data. Longman

Practical Course

Petrographic calculations

1. CIPW Norm calculations
2. Niggli Values calculations

M.Sc.-I Geology
Title: Structural Geology

Course: M.S.Geo.1.03

Learning Objectives:

Number of lectures: 60

Unit I

(15 lectures)

Introduction

Principles of geological mapping and map reading
Projection diagrams
Stress-strain relationships of elastic, plastic and viscous materials

Unit II

(15 lectures)

Time Relationship and Behaviour

Time-relationship between crystallization and deformation
Structural behaviour of igneous rocks

Unit III

(15 lectures)

Mechanics and Measurement of Deformation

Mechanics of deformation: folding and faulting
Unconformities and basement-cover relations
Measurement of strain in deformed rocks

Unit IV

(15 lectures)

Diapirs and Salt Domes

Behaviour of minerals and rocks under deformation conditions
Diapirs and salt domes

Reference Books:

1. Hatcher R.D., Jr. (1990) Structural Geology: principles, concepts and problems. Merrill Publishing Co.
2. Park R.G. (1997) Foundations of Structural Geology. Chapman & Hall.
3. Badgley P.C. (1959) Structural Methods for exploration geologists. Harper & Brothers, New York.
4. Hills E.S. (1953) Outlines of Structural Geology. Meuthen Co., London.

Practical Course:

1. Interpretation of geological maps
2. Structural problems.

M.Sc.-I Geology
Title: Igneous Petrology

Course: M.S.Geo.1.04

Learning Objectives:

Number of lectures: 60

Unit I

(15 lectures)

Magmas 1

Nature and types of magmas
Cooling behaviour of magmas

Unit II

(15 lectures)

Magmas 2

Properties of magma
Evolution and sources of magmas

Unit III

(15 lectures)

Petrographic Provinces in relation to Plate Tectonic Setting 1

Oceanic basalts
Continental basalts
Tholeiitic basalts
Continental deep source

Unit IV

(15 lectures)

Petrographic Provinces in relation to Plate Tectonic Setting 2

Continental, marginal and island arc andesitic
Continental plutonic, granitic and anorthositic
Orogenic belt ultramafic

Reference Books:

1. Best M.G. (2002) Igneous and metamorphic petrology. John Wiley & Sons.
2. Carmichael I.S.E, Turner F. J. and Verhoogen J. (1974) Igneous and metamorphic petrology. McGraw Hill.
3. Hall Anthony (1987) Igneous Petrology. Longman Scientific & Technical.
4. Hyndman D.W. (1985) Petrology of Igneous and Metamorphic rocks. McGraw Hill.
5. Nockolds S.R., Knox R.W. O'b and Chinner G.A. (1978) Petrology for students. Cambridge University Press.

Practical Course:

1. Megascopic examination of igneous rocks.
2. Microscopic examination of igneous rocks.
3. Variation diagrams of igneous rocks.

4. Interpretation of differentiation trends by AFM diagrams.

M.S.Geo. 1.01, 1.02, 1.03, 1.04 courses

Evaluation (Theory): Total marks per course - 100.

CIA- 40 marks

CIA 1: Written test -20 marks

CIA 2: Assignment -20 marks

End Semester Examination – 60 marks

One question from each unit for 15 marks, with internal choice. Total marks per question with choice -20 to 21.

Evaluation (Practicals) Total marks per Practical course - 50.

CIA: 20 marks: Lab viva on performed experiment and Journal.

End Semester Practical Examination – 30 marks.

Template for S.Geo courses End Semester examination in Semester 1

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	08	04	03	15
2	08	04	03	15
3	08	04	03	15
4	08	04	03	15
-TOTAL - Per objective	32	16	12	60
% WEIGHTAGE	53	27	20	100%

St. Xavier's College, Mumbai
Department of Geology
Assessment Grid for M.Sc. Semester 1 CIA 2-Assignment
CIA 2 Course M.S.Geo: _____

Roll Number: _____

REPORT (Parameters)	Marks	80 – 100% Excellent	60 -80% Good	40 – 60% Satisfactory	20 – 40% Poor	0 – 20% Very Poor
Reference Papers reviewed	10					
Stratigraphy/ Petrology/ Structural Geology/ Maps /Imagery prepared	10					
Total	20					

Evaluator's Name Signature and date

Name

Signature & date



St. Xavier's College
Mumbai

Syllabus
for IInd Semester Courses in
M.Sc. Geology
(November 2013 onwards)

Courses:

M.S.Geo.2.01 – Remote Sensing and Image Interpretation

M.S.Geo.2.02 - Igneous Petrology

M.S.Geo.2.03 – Metamorphic Petrology

M.S.Geo.2.04 – Sedimentary Petrology

Practical Course:

M.S.Geo.2.01. PR, M.S.Geo.2.02. PR, M.S.Geo.2.03. PR
and M.S.Geo.2.04. PR. (Pertinent to the above mentioned
theory courses)

M.Sc-I Geology Course: M.S.Geo.2.01
Title: Remote Sensing and Image Interpretation

Learning Objectives:

Understand the analytical aspects of image processing with special emphasis on processing remotely sensed imagery for geological data interpretation, field mapping.

Number of lectures: 60

UNIT 1

(15 lectures)

Concepts of Remote Sensing

Satellite imaging technology - Definitions of: Resolution, Classification of sensors, Accuracy and precision, Geolocation, georeferencing and geocoding., Orthoimages, Image products. Principles: Satellite Orbits, Geometry of a single image, Acquisition of stereoscopic data, Height from stereoscopic data, Ground control, Accuracy. History of optical sensors in space

UNIT 2

(15 lectures)

Principles of High Resolution Optical Sensors

Across track stereo, Along track stereo, Spatial and radiometric aspects, Sensor optics, Data recording and transmission, Sensors with GSD 1m to 16m and 1m or less.

UNIT 3

(15 lectures)

Introduction to Digital Image Processing

Introduction.
Image Rectification and Restoration.
Image Enhancement.
Contrast Manipulation.
Spatial Feature Manipulation.
Multi-Image Manipulation.

UNIT 4

(15 lectures)

Digital Imaging classification

Image Classification: Supervised Classification.
The Classification Stage: Minimum-Distance to Means Classifier, Parallelepiped Classifier, Gaussian Maximum Likelihood Classifier.
The Training Stage.
Unsupervised Classification.
Subpixel classification,
Hyperspectral Image Analysis
Classification Accuracy Assessment.

List Of Recommended Reference Books

1. Dowman Ian., Karsten Jacobsen., Gottfried Konecny and Rainer Sandau (2012), High Resolution Optical Satellite Imagery., Whittles Publishing.
 2. Schowengerdt Robert A., (2007), Remote Sensing – Models and Methods for Image Processing, 3rd ed., Elsevier (Academic Press).
 3. Lillisand T. M., Ralph W. Kiefer and Jonathan W. Chipman (2007), Remote Sensing and Image Interpretation, 6th ed, Wiley.
 4. Jensen John R. (2000), Remote Sensing of the Environment – An Earth Resource perspective, Pearson Education Series, Low Price Edition.
 5. Drury S.A., (1993), Image Interpretation in Geology, 2nd ed., Chapman and Hall, London.
 6. Ramasamy S.M., (2005), Remote Sensing in Geomorphology, New India Publishing Agency.
 7. Mather Paul M., (2004), Computer Processing of Remotely Sensed Images- An Introduction, 3rd ed., John Wiley.
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Practical Course:

Remote Sensing and Image Processing

- Interpretation of Satellite imagery for : Landuse/Landcover, Geomorphology, Geology.
 - Digital Image Processing (using number matrix): enhancement, manipulation and classification.
 - Digital image processing on Computer
 - Display of various types of image formats
 - Palettes and Display elements
 - Georeferencing
 - Image enhancement
 - Image classification
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M.Sc-I Geology Course: M.S.Geo.2.02
Title: Igneous Petrology

Course Objectives: To understand the principles and processes involved in the evolution and formation of Igneous rocks and provinces, and their significance in deciphering the Earth's evolution.

Number of lectures: 60

Unit 1: (15 lectures)

Role of Magma In Geological Processes

Magma definition, its physical property- Geothermal gradient and heat source.
Magmatism and plate tectonics.
Igneous texture and structure and their genetic significance.
Classification of Igneous rocks - historic perspective and the IUGS systematic
Igneous activity at the present day

Unit 2: (15 lectures)

Geochemical Tracers of Mantle Process

Introduction
Continental and Oceanic mantle Lithosphere.
MORB and depleted mantle.
OIB and enriched mantle.
Island arc basalt.
Concept of Hot Spots
Mantle Plumes- theory and structure
Trace Elements in Igneous processes- Melting and crystallization models- Application of trace elements to petrogenesis

Unit 3: (15 lectures)

Magma Evolution and Crystallisation

Igneous processes and diversity in igneous rocks.
Compositional variation in magmas
Magmatic differentiation
Mixing of magma
Assimilation of magma
Phase relations of silicates and silicate melt.
Binary and ternary system.
Partial melting

Unit 4: (15 lectures)

Petrogenetic Provinces

Large Igneous Provinces: Basaltic associations of continental areas, Basaltic rocks of the Ocean Basins.
Ophiolites.

Layered Gabbroic Intrusions.

Alkaline rocks, Nephelinites and Ijolites, Lamprophyres.

Carbonatites, Anorthosites, Kimberlites, Lamproites : Geology and Distribution in India.

Granites and Granitic rocks

Practical Course:

1. Megascopic and Microscopic identification of igneous rocks.
2. CIPW normative calculation of igneous rocks.
3. Application of trace elements in igneous petrology.

List of Recommended Reference Books :

1. Bose M.K. (1997), Igneous Petrology. The World Press Pvt. Ltd. 568 p.
2. Bowen N.L. (1928), The evolution of Igneous Rocks. Princeton Univ. Press. N.J 332 p.
3. Hall A. (1987), Igneous Petrology. Longman. 573p.
4. Hatch F.H., Wells A.K and Wells M.K. (1984), Petrology of the igneous rocks. CBS Publishers, 551 p.
5. Philpotts A.R. (1994), Principles of igneous and metamorphic Petrology, Prentice Hall of India. 498p.
6. Turner F.J & Verhoogen J. (1951), Igneous and Metamorphic Rocks, McGraw Hill.
7. Williams H, Turner F.J & Gilbert C.M. (1955), Petrography. San Francisco: W.H. Freeman and company. 406p
8. Winter J. D. (2001), an Introduction to Igneous and Metamorphic Petrology, Prentice Hall, 697p.
9. Ehlers, E.G. and H. Blatt (1982), Petrology, Igneous, Sedimentary and Metamorphic, W.H Freeman, San Francisco.

M.Sc-I Geology Course: M.S.Geo.2.03

Title: Metamorphic Petrology

Learning Objectives: To understand the metamorphism and its controlling factors, to understand concept of metamorphic facies and significance of metamorphic mineral assemblages. To relate metamorphic textures with deformation conditions and to understand role of global tectonics in metamorphism.

Number of lectures: 60

Unit 1: (15 lectures)

Metamorphism and its controlling factors

Metamorphism and its limits

Metamorphic agents and changes: Role of temperature, pressure, stress and fluids

Types of metamorphism

Types of protolith

Classification of metamorphic rocks

Structures and textures of metamorphic rocks

Analysis of polydeformed and polymetamorphosed rocks

Analytical techniques

Unit 2: (15 lectures)

Thermodynamics and metamorphism

Phase rule and phase diagram

Chemographic diagrams: Basic concepts and common diagrams in metamorphic petrology

Projections in chemographic diagrams

Metamorphic facies and facies series

Types of metamorphic reactions

Petrogenetic grids

P-T-t paths

Calculation of equilibrium curve for metamorphic reactions

Examples of thermometry and barometry

Unit 3: (15 lectures)

Types and products of metamorphism-1

Metamorphism of pelitic rocks

Migmatites: Types and formation processes

Metamorphism of carbonate rocks

Metamorphism of mafic rocks

Unit 4: (15 lectures)

Types and products of metamorphism-2

Metamorphism of granitoids.

Charnockites

Metamorphic fluids, mass transport and metasomatism.

Impact metamorphism and Retrograde metamorphism.

Tectonics and metamorphism, Paired metamorphic belts

Practical Course:

Metamorphic petrology

· Plotting rock compositions on chemographic diagrams: ACF, AKF and AFM.

· Study of hand specimen of metamorphic rocks

Slate, Phyllites, Quartzite, Schists, Gneisses, Granulites, Khondalite, Leptynite, Charnockite, Eclogite, Amphibolite, Migmatite, Blueschist, Breccia, Mylonite,

· Study of thin sections of

a) Metapelitic rocks

b) Metabasic rocks

c) Granulites and eclogite

d) Marbles

List of Recommended Reference Books

1. Winter, John D. (2010): Principles of igneous and metamorphic petrology, PHI learning Pvt. Ltd.
2. Philpotts, A and Ague, J (2009): Principles of igneous and metamorphic petrology, Cambridge University Press
3. Williams H, Turner F.J & Gilbert C.M. (1955), Petrography, W.H. Freeman and company. San Francisco, 406p.
4. Blatt H., Tracy R.J. and Owens B.E. (2006), Petrology – Igneous, sedimentary and Metamorphic (3rd Edition), W.H. Freeman and Company, New York.
5. Passicher C.W, Myers J.S and Kroner A. (1990), Field geology of high grade gneiss terraines; Narosa Publishing house, Springer Verlag and IUGS
6. Yardley Bruce W.D. (1989), An Introduction to Metamorphic Petrology, Longman Singapore Publishers (Pvt.) Ltd.
7. Miyashiro A. (1998), Metamorphism and Metamorphic Belts, George Allen & Unwin, New York.
8. Mason Roger (1984), Petrology of the Metamorphic Rocks, CBS Publishers and Distributors, New Delhi.
9. Winkler Helmut G.F. (1987), Petrogenesis of Metamorphic Rocks (Fifth Edition), Narosa Publishing House, New Delhi.

M.Sc. Geology Course: M.S.Geo.2.04
Title: Sedimentary Petrology

Course Objectives:

Understanding different sedimentary processes, rocks and structures and their associated environment.

Application of Sedimentary petrology in understanding different geological processes.

Number of lectures: 60

Unit-1 (15 lectures)

Sediment transport and deposition, fundamentals of fluid dynamics

Sedimentary textures: grain size, sorting, shape, etc.

Sedimentary structures: lamination, ripples, cross-bedding etc.

Unit-2 (15 lectures)

Siliciclastic sedimentary rocks, classifications, Siliciclastic diagenesis

Siliciclastic marine environments

Fluvial depositional environments

Unit -3 (15 lectures)

Carbonate sedimentary rocks, classification and diagenesis

Carbonate marine environments

Biochemical and evaporitic rocks

Unit-4 (15 lectures)

Eolian and lacustrine environments

Glacial environment

Deltaic and beach barrier island environments

Estuarine, lagoonal and tidal environments

Practical Course:

Sedimentary petrology

Rock Specimens of different sedimentary rocks and structures

Thin section of sedimentary rocks

Grain Size analysis

Paleocurrent analysis

List of Recommended Reference Books

1. Miall, A.D. (2000): Principles of Basin Analysis, Springer-Verlag.
2. Pettijohn, F.J. (1975): Sedimentary Rocks (3rd Ed.), Harper and Row Publ., New Delhi.
3. Reading, H.G. (1997): Sedimentary Environments and facies, Blackwell Scientific Publication.
4. Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments, Springer-Verlag.
5. Selley, R. C. (2000) Applied Sedimentology, Academic Press.

6. Tucker, M.E. (2001): Sedimentary Petrology: An Introduction, Wiley and Sons, New York.
7. Tucker, M.E. (1990): Carbonate Sedimentology, Blackwell Scientific Publication
8. Stow Dorrik A.V(2011): Sedimentary Rocks in the Field , A Colour guide. Manson Publishing House Ltd.
9. Nichols Gary (2009): Sedimentology and Stratigraphy., Wiley India.



St. Xavier's College
Mumbai

Syllabus
for IIIrd Semester Courses in
M.Sc. Geology
(June 2013 onwards)

Courses:

M.S.Geo.3.01 – General and Invertebrate Paleontology

M.S.Geo.3.02 – Hydrogeology

M.S.Geo.3.03 – Geophysical Prospecting

M.S.Geo.3.04 – Coal and Petroleum Geology

Practical Course:

M.S.Geo.3.01. PR, M.S.Geo.3.02. PR, M.S.Geo.3.03. PR and
M.S.Geo.3.04. PR. (Pertinent to the above mentioned theory
courses)

M.Sc-II Geology Course: M.S.Geo.3.01

Title: General and Invertebrate paleontology

Learning Objectives: To understand scope and applications of paleontology and to learn morphology and classification of invertebrate fossil fauna. To understand trace fossils and taphonomic record with Indian examples

Unit -1: (15 lectures)

Introduction

Paleontology, definition, subdivisions and scope, its relationship with other sub-disciplines of geology; Fossils, definition, characters, kinds (body and trace fossils); Conditions of fossilization; Incompleteness of fossils record; Bathymetric distribution of organisms. Modern systematics; Concept and kind of type specimens; Trans-specific evolution, speciation and radiation.

Unit -2: (15 lectures)

Invertebrate paleontology-1

Chief characteristics, Evolutionary trends and geological history of following groups:

Brachiopoda

Mollusca (Bivalvia, Gastropoda, Cephalopoda)

Echinoidea

Unit -3: (15 lectures)

Invertebrate paleontology-2

Chief characteristics, Evolutionary trends and geological history of following groups:

Trilobita, Cnidaria (Corals), Graptoloidea.

Ichnofossils, their modes of preservation, behavioral classification and ichnofacies.

Unit -2: (15 lectures)

Paleoecology paleoenvironment

Approaches to paleoecological and paleoenvironmental studies based on benthic communities, trace fossils and taphonomic record with Indian examples; Micro and macroevolution.

Distribution, migration and dispersal of organisms applied to paleobiogeography and plate tectonics with Indian examples.

Practical Course:

General and Invertebrate paleontology

Study of the morphological characters of some important invertebrate fossils belonging to Brachiopoda, Bivalvia, Gastropoda, Ammonoidea, Trilobita, Echinoidea and corals; Study of ammonoid suture pattern.

List of Recommended Reference Books

- 1) Clarksons, E.N.K. (1998): Invertebrate Paleontology and Evolution, Allen and Unwin, London.
- 2) Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill.
- 3) Raup, D.M. and Stanley, S.M. (1985): Principles of Paleontology ,CBS Publ..
- 4) Smith, A.B.(1994): Systematics and Fossil Record – Documenting Evolutionary Patterns, Blackwell.
- 5) Streat, C.W. and Carroll, R.L. (1989): Paleontology – the record of life, John Wiley.
- 6) Shrock, Robert R. and Twenhofel, William H. (2002): Principles of Invertebrate Paleontology, (McGraw Hill) Dist. CBS Publishers.
- 7) Benton, Michael J. and Harper, David A.T. (2009): Introduction to Paleobiology and fossil record, John-Wiley & Sons.

M.Sc-II Geology Course: M.S.Geo.3.02

Title: Hydrogeology

Learning Objectives: To understand origin, occurrence and movement of groundwater and to study surface and subsurface methods of groundwater exploration. To study impact of geology on groundwater distribution in India.

Unit -1: (15 lectures)

Origin and occurrence of groundwater

Groundwater in Hydrologic Cycle

Origin and age of Groundwater

Vertical Distribution of Groundwater

Impact of Geologic formations and structure, on groundwater flow

Groundwater distribution of India

Movement of groundwater:

Origin and types of springs and hot springs

Darcy's law

Permeability

Determination of Hydraulic Conductivity

Unit -2: (15 lectures)

Well Hydraulics:

Pumping test

Field and lab analysis of hydraulic conductivity

Steady and Unsteady flow

Radial and Unidirectional flow to well,

Saline water intrusion in Aquifers- Ghyben-Herzberg relation between Fresh and Saline water

Unit -3: (15 lectures)

Environmental influences on groundwater

Causes for Fluctuation in water table

Artificial Recharge of Groundwater

Quality of groundwater:

Chemical Analysis and Graphical Representation for Quality of Groundwater

Water-Quality Standards and collection of Water Samples

Ground-Water Monitoring

Ground-Water Contamination

Unit-4 (15 lectures)

Surface and subsurface methods for investigation of groundwater:

Surface investigation of groundwater

Resistivity Method

Seismic Method

Gravity and Magnetic Method

Resistivity Logging
Spontaneous Potential Logging

Practical Course:

Hydrogeology

Groundwater contour maps and flow nets
Analysis of rainfall data
Resistivity data interpretation
Groundwater flow problems

List of Recommended Reference Books

1. Nath, Sankar Kumar, Patra, Hari Pada, & Shahid, Shamsuddin [2000] Geophysical Prospecting for Groundwater. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Mazof s, E., (1988) Applied Chemical Groundwater Hydrology McGill.
3. Ingebritsen, Steve, Stanford, Ward & Neuzil, Chris (2006) Groundwater in Geologic Processes. 2nd edition, Cambridge University Press, U.K.
4. Assad, Fakhry, LaMoreaux, Phillip E., & Hughes, Travis H. ed. (2003) Field methods for Geologists and Hydrogeologists. Springer-Verlag, Berlin.
5. Brassington, R., (1988) Field Hydrogeology John Wiley & Sons, Chichester.
6. Todd., D.K. (1995) Groundwater Hydrology John Wiley & Sons, London.
7. Walton, W.C. Groundwater Resource Evaluation latest Ed., McGraw Hill.
8. Micheal, P., (1985) Introduction to Groundwater George Allen & Unwin, London.
9. Fetter, C.W., (1994) Applied Hydrogeology MacMillan Pub. Comp. New York.
10. Rangunath, H.M., (1992) Groundwater Wiley Eastern Ltd. New Delhi.
11. Bouwer, Herman (1978) Groundwater Hydrology. McGraw Hill, Inc., New Delhi.

M.Sc-II Geology Course: M.S.Geo.3.03

Title: Geophysical Prospecting

Learning Objectives: To understand basic concepts, scope and applications of geophysical prospecting. To learn methods of logging and log interpretation.

Unit-1

(15 Lectures)

Introduction

Introduction to Geophysical Prospecting and historical background
Overview of Geophysical Prospecting methods

Seismic Methods

Fundamentals of Seismic prospecting
Seismic instruments, measurements and field operations
Seismic refraction method
Seismic reflection method
Geological interpretation of refraction and reflection data

Unit-2

(15 Lectures)

Gravity Methods

Fundamentals of Gravity prospecting
Instruments, measurements and field operations
Geological interpretation of Gravity Data

Magnetic Methods

Fundamentals of Magnetic prospecting
Instruments, measurements and field operations
Geological interpretation of Magnetic Data

Unit-3

(15 Lectures)

Electrical Methods

Electrical properties of rocks and minerals
Methods employing Natural Electrical sources:
 (a) Self-potential (b) Telluric and Magnetotelluric
Resistivity method
Induced Polarization method
Geological interpretation of Electrical Data

Electromagnetic Methods

Fundamentals of electromagnetic surveys
Instruments and field settings
Geological interpretation of EM Data

Unit-4

(15 Lectures)

Radioactivity methods

Fundamentals of radioactivity surveys

Instruments and field settings

Geological interpretation of Radioactivity Data

Geophysical Well Logging

Introduction to well logging

General aspects well logging and historical background

Common logging methods:

- | | | |
|-----------------------|------------------------|-----------------|
| (a) Resistivity log | (b) Self-potential log | (c) Sonic log |
| (d) Neutron log | (e) Gamma-ray log | (f) Density log |
| (g) Well bore seismic | (h) Image logs | |

Well-log interpretation

List of Recommended Reference Books:

1. Dobrin, Milton B. (1960): Introduction to Geophysical Prospecting, McGraw-Hill Book Company, Inc.
2. Milsom, J. and Asger, E. (2011): Field Geophysics, 4th edition, Wiley and Sons Ltd.
3. Committee on Geodesy, National Research Council (1995): Airborne Geophysics and Precise Positioning: Scientific Issues and Future Directions, National Academics Press.
4. Gadallah, M. and Fisher, R. (2009): Exploration Geophysics, Springer-Verlag Berlin Heidelberg.
5. Kalyan Kumar Roy (2008): Potential Theory in Applied Geophysics, Springer-Verlag Berlin Heidelberg.
6. Kearey, Brooks and Hill (2002): An Introduction to Geophysical Exploration, Third Edition, Blackwell Science.
6. W. M. Telford, L. P. Geldart and R. E. Sheriff (2004): Applied Geophysics, Second Edition, Cambridge University Press.

Practical Courses:

1. Calculations and interpretation based on Seismic Data
2. Calculations and interpretation based on Gravity Data
3. Calculations and interpretation based on Electrical Data
4. Exercises on Log interpretation
5. Exercises on Log correlation

M.Sc-II Geology Course: M.S.Geo.3.04

Title: Coal and petroleum geology

Learning Objectives: To understand origin, properties, classification of coal and petroleum. Learning exploration methods, and coal/petroleum bearing rock formations in India.

Unit-1 (15 lectures)

Generation and migration of petroleum

Physical and chemical properties of petroleum

i) Natural gases

ii) Gas hydrates

iii) Crude oil

Classification of petroleum

Generation and migration of petroleum

Origin of petroleum: Organic or Inorganic

Modern organic processes on the earth's surface

Formation of kerogen

Petroleum migration

Petroleum system

Unit-2 (15 lectures)

Reservoir and cap rocks

The Reservoir

Porosity, Permeability, Capillary pressure, Relationship between Porosity, Permeability and

Texture, Effects of diagenesis on reservoir quality

Reservoir continuity and characterization

Reserve calculations and Production methods

Traps and Seals

Nomenclature of a trap

Distribution of petroleum within a trap

Seals and cap rock

Classification of traps

Unit-3 (15 lectures)

Origin and distribution of coal

The origin of coal

Sedimentation of coal and coal bearing sequences

Structural effects on coal

Age and occurrence of coal

Plate tectonics

Stratigraphy

Coal as a substance
Physical description of coal
Coalification (Rank)
Coal quality
Classification of coals

Unit-4

(15 lectures)

Sampling and analysis of coal

Coal sampling and analysis
In situ coal sampling
Non *in situ* coal sampling
Coal analysis
Geology and coal mining
Underground mining
Open cast or surface mining

Practical courses

Coal and petroleum geology

Isopach and isolith maps
Outcrop completion, fault and borehole problems
Reserve estimation problems
Seismic profile interpretation
Borehole correlation

List of Recommended Reference Books

1. Thomas L. (2012), Coal Geology, Wiley India Pvt. Ltd.
2. Francis W. (1964), Coal its formation and composition, Edward Arnold (Publishers) Ltd.
3. Deshpande B.G. (1992), The world of petroleum, Wiley Eastern Ltd. New Delhi.
4. Selley R.C. (1998), Elements of petroleum geology, Academic Press.
5. Ashcroft, W. (2011), A geologist's guide to seismic reflection, John Wiley and sons
6. Leverson, A.I (2006): Geology of Petroleum, CBS publications



St. Xavier's College
Mumbai

Syllabus
for IVth Semester Courses in
M.Sc. Geology
(November 2013 onwards)

Courses:

M.S.Geo.4.01 – Micropalaeontology and Oceanography

M.S.Geo.4.02– Engineering Geology

M.S.Geo.4.03 – Economic Geology

M.S.Geo.4.04* – Dissertation

Practical Course:

M.S.Geo.4.01. PR, M.S.Geo.4.02. PR, M.S.Geo.4.03. PR

(Pertinent to the above mentioned theory courses)

M.Sc-II Geology Course: M.S.Geo.4.01

Title: Micropalaeontology and Oceanography

Learning Objectives: To give an insight of the various microfossils with respect to their morphology, shell composition and their habitats. To emphasize on the applications of various microfossils in the field of paleoclimatology, paleoceanography and biostratigraphy.

Number of lectures: 60

Unit 1: (15 lectures)

Definition and scope of the subject; Relationship of micropaleontology with ocean sciences; Modern field and laboratory techniques in the study of microfossils (collection, sampling and processing techniques, scanning electron microscopy and mass spectrometry).

Types of Microfossils

Calcareous Microfossils:

(i) Foraminifera - planktic foraminifera, their modern biogeography, outline of morphology, significance in Cenozoic oceanic biostratigraphy and paleoceanographic, paleoclimatic interpretations.

Benthic foraminifera – outline of morphology; application in deep-water paleoceanography and paleobathymetric reconstructions.

Larger foraminifera- their outline of morphology and application in stratigraphy;

(ii) Calcareous nannofossils - outline of morphology, modern biogeography and their application in oceanic biostratigraphy and paleoceanographic, paleoclimatic reconstructions.

(iii) Pteropoda - a brief introduction, application of pteropods in reconstruction of the Quaternary oceanography and climate;

Organic Walled Microfossils:

Organic walled microfossils and their significance, significance of spores, pollen, in biostratigraphy, Concept of palynofacies and its application in paleoenvironment interpretation.

Unit 2: (15 lectures)

Types of Microfossils

Siliceous Microfossils:

Radiolaria and diatoms - outline of morphology, modern biogeography, their environmental significance and application in biostratigraphy.

Phosphatic Microfossils:

Conodonts - outline of morphology, paleoecology, geological significance and biological affinities; Stratigraphic significance of conodonts with special reference to India.

Micropaleontology in petroleum exploration; Environmental significance of microfossils; Geochemical study of microfossil tests (stable isotopes, radiocarbon isotopes and elemental composition) and its application in paleoceanography and paleoclimatology; Application of palynology in identifying ancient coast lines; Role of micropaleontology in marine geology and oceanography.

Unit 3:

(15 lectures)

History of development of oceanography; Sampling of modern ocean biogenic flux including sediment trap sampling; Methods of measuring properties of sea water; Temperature and salinity distribution (horizontal and vertical) in ocean waters; Dissolved gases in sea water, factors affecting the concentration of gases in sea water; Carbon dioxide equilibria, precipitation and dissolution of carbonates; Biological - chemical - physical interactions in the oceans; Oxygen minimum layer in the ocean. Scientific ocean drilling and its major accomplishments

Unit 4:

(15 lectures)

Concept of mixed layer, thermocline, pycnocline halocline, and pycnocline, Coriolis force and Ekman spiral, upwelling, El Niño and La Nina, Ocean circulation- surface circulation; deep ocean circulation (concept of thermohaline circulation, formation of bottom waters, water masses of the world oceans, oceanic sediments).

Practical Course

Micropaleontology

Types of microfossils - calcareous, siliceous, and organic walled microfossils; Microscopic study of important planktic and benthic foraminifera; Study of larger benthic foraminifera.

Oceanography

Depth biotopes; Identification of planktic foraminifera characteristic of warm and mixed layer, thermocline and deep surface water of the modern oceans;

Quantitative study of planktic foraminifera and their interpretation in relation to paleoclimatology.

List of Recommended Reference Books

1. Kennett, J.P. and Srinivasan, M.S. (1983): Neogene Planktonic Foraminifera- a phylogenetic atlas, Hutchinson Ross Publishing Company.
2. Bignot, G., Grahm and Trotman (1985): Elements of Micropaleontology, Micropaleontology Press, London.
3. Armstrong, H.A. and Brasier, M. (2005): Microfossils, Blackwell Publishing, Australia.
4. Pinet, Paul R. (2006): Invitation to Oceanography, Jones & Bartlett Learning.
5. Grant Gross, M. (1995): Oceanography; A view of the Earth (7th Ed.), Prentice Hall.
6. Garrison, T. (2007): Oceanography: an invitation to marine sciences, Cengage Learning.
7. Haq, Bilal and Boersma, Anne (Ed.) (1998): Introduction to Marine Micropaleontology, Elsevier.
8. Bradley, R.S. (Ed.) (1999): Paleoclimatology (2nd Ed.), Elsevier.
9. Marcel, C.H. and Vernal, A.D. (Ed.) (2007): Proxies in Late Cenozoic Paleoceanography, Elsevier.

M.Sc-II Geology Course: M. S.Geo.4.02

Title: Engineering Geology

Learning Objectives: To understand the engineering properties of rocks. Detailed study of various geological and geotechnical investigations for various civil engineering projects.

Number of lectures: 60

Unit 1:

(15 lectures)

Rock and soil mechanics

Techniques of determining properties of rocks and soil:

Specific Gravity

Porosity

Sorption

Compressive Strength

Tensile Strength

Elasticity of Rocks

Residual Stress and Shear Stress in Rocks.

Soil mechanics

Rocks as construction material

Unit 2:

(15 lectures)

Geological and Geotechnical investigations for Civil Engineering Projects:

1. **Geotechnical investigations-** Sounding, Drilling equipment and methods, Wash borings, core samples, borehole logs.

2. **Building site exploration-** Types of foundations, load tests, groundwater problem. Commercial, residential and industrial building site investigation

3. **Tunnels:** Terminology, Geological conditions for tunnel sites, Tunnels in folded rocks and bedded rocks. Influence of divisional planes, Effects of faults, Crushed zones, Tunnels near slopes, Role of Groundwater in tunneling.

4. **Bridges and pavements-** Abutments and piers, foundations, cofferdams, Caissons, rigid and flexible pavement. Site exploration.

Unit 3:

(15 lectures)

Tunnels and shoreline engineering

1. **Tunnels-** Terminology, technical classification, roof bolting, arching, effect of bedding orientation on tunnels. Gases and water in tunnels, geothermal gradient. Methods of tunnel excavation and site exploration

2. **Shoreline engineering-** Beach and shorelines, construction of shore cliffs and steep banks, Littoral barriers, harbour location, sedimentation in harbours and jetties.

3. **Earthquakes and Aseismic design of buildings**

Unit 4:

(15 lectures)

Dams, reservoirs and landslides

1. **Dams and Reservoirs:** Geological conditions for the selection of dam and reservoir sites.

Terminology associated with dams. Types of dams: Masonary Dams (Gravity Buttress and Arch types), Earthen dams. Types of spillways. Case studies of dam construction and failures.

2. **Landslides-** Causes, types and prevention of landslides.

Practical Course:

Engineering Geology

- Correlation of borehole data
- determining uniaxial compressive strength of rock
- Equal-area net- Determining slope stability and rotation problems.

List of Recommended Reference Books

1. Waltham, T. (2009): Foundations of engineering geology, 3rd edition, CRC press
2. Vallejo, L.G, Mercedes, F., Freitas, M. (2011): Geological Engineering, 1st edition, CRC press
3. West, T.R (2010): Geology applied in Engineering, Waveland Pr Inc; 1 edition
4. Narayanswami S.B.S. (2000), Engineering Geology, Dhanpat Rai & Co, India.
5. Legget F. R and Hatheway A.W. (1988), Geology and Engineering., 3rd ed. McGraw-Hill.
6. Gupte R.B. (1992), A Textbook of Engineering Geology.2nd ed. Pune Vidyarthi Griha Prakashan.
7. Krynine D.P. And Judd W.R (2003), Principles of Engineering Geology and Geotechniques, CBS Publishers.
8. Wahlstrom E.E. (1974), Dams, Dam Foundations and Reservoir Sites. Elsevier Scientific.
9. Dunn I.S., Anderson L.R and Kiefer F.W. (1980), Fundamentals of Geotechnical Analysis, John Wiley.
10. Maslov N.N. (1987), Basic Engineering Geology and Soil Mechanics. Mir Publishers.
11. Gokhale K.V.G.K and Rao D.M. (1981), Experiments in Engineering Geology. Tata McGraw-Hill

M.Sc-II Geology Course: M.S.Geo.4.03

Title: Economic Geology

Learning Objectives: To understand the various processes of ore formation, with special reference to the distribution in India.

Number of lectures: 60

Unit 1: (15 lectures)
Concept of ore bearing fluids, their origin and migration; Processes of formation of ore deposits- metasomatic, hydrothermal and supergene enrichment; Controls of ore localization; Ore deposits and plate tectonics.

Unit 2: (15 lectures)
Mineralogy, classification and genesis of ore deposits associated with mafic-ultramafic rocks; Ores of felsic-silicic rocks; Ores of sedimentary affiliation; Ores of metamorphic affiliation; Placer and residual concentration deposits.

Unit 3: (15 lectures)
Study of ore minerals related to the following metals with special reference to their mineralogy, genesis, specification, uses and distribution in India:
Iron, Manganese, Base Metals, Chromium, Gold, Tin and Tungsten.

Unit 4: (15 lectures)
Study of important Indian ore deposits with reference to their geology, stratigraphy and reserves; A few case studies of occurrence of economic mineral deposits from provinces other than Indian sub-continent.

Practical Course:

Identification of important ore minerals in hand specimens.
Ore microscopy- textures, microstructures, optical properties of ores.

List of Recommended Reference Books

1. Branes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Wiley.
2. Cuilbert, J.M. (1986): The Geology of Ore Deposits, Freidman.
3. Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
4. Jensen M.R. and Bateman A.M. (1981), Economic mineral deposits, John Wiley & Sons.
5. Craig, J.R. and Vaughan, D.J. (1994): Ore Microscopy and Petrography.
6. Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits, Springer-Verlag.
7. Wolf, K.H. (1976-1981): Handbook of Stratabound and Stratiform Ore deposits, Elsevier.
8. Mookherjee, A. (1999): Ore Genesis- A Holistic Approach., Allied Publishers.

M.Sc.II Geology Course: M.S.Geo.4.04

DISSERTATION

(Topic for dissertation will be assigned during the 3rd semester.)

Evaluation of Dissertation: (CIA - 40%, Dissertation report and Viva - 60%)

CIA I: (30 marks):Reference work - pre-field / pre lab literature survey, preparation of field material (toposheet, satellite imagery etc)

CIA II: (30 marks): Field work , Lab work, Geological mapping, Sample collection, field diary.

End Semester Examination: Dissertation Report and Open Viva: (90 marks)

Dissertation report - 60 marks

Viva voce - 30 marks
