St. Xavier's College
Mumbai

Syllabus
for B.Sc VIth Semester Courses in Geology
(November 2016 onwards)

Contents:

T.Y. B.Sc. Geology **Course: S.Geo.6.01**
Title: Phanerozoic Geology of India

Learning Objectives: To bring about an understanding of the principals of stratigraphy and Understand the Phanerozoic stratigraphy of India.

Unit 1: **(15 lectures)**
Palaeozoic History
Tectonic History
Precambrian Cambrian Boundary
Marine Palaeozoic Formations of India
- Kashmir Basin
- Spiti Basin
- Krol Basin

Unit 2: **(15 lectures)**
Mesozoic History
Tectonic History
Permian Triassic Boundary
Marine Mesozoic Formations of India - Kashmir Basin
Marine Transgressive Sequences of Kachchh and Tiruchirapalli.

Unit 3: **(15 lectures)**
Gondwana Sequence of India
Sedimentation and Palaeoclimates
Lower Gondwana Sequence of different basins.
Upper Gondwana Sequence of different basins.

Unit 4: **(15 lectures)**
Cenozoic History
Tectonic History
Boundary Problems
Indian Palaeogene - Neogene Formations:
- Siwalik Supergroup
- Assam –Arakan Region
- Andaman-Nicobar Islands
- Sirmur Group

Geology and Stratigraphy of Maharashtra
- Deccan Flood Basalts.

Reference Books:

1. Dasgupta, A. (2010) Phanerozoic Stratigraphy of India; World Press, Kolkata.
2. Deshpande, G.G. (1998) Geology of Maharashtra; Geological Society of India, Bangalore.
3. Directorate of Geology and Mining, Nagpur. (2000) Geology and Mineral Resources of Maharashtra.
4. Krishnan, M.S. (1982) Geology of India and Burma; 6th Ed. CBS Publishers & Distributors (India).
5. Kumar, R. (1996) Fundamentals of Historical Geology and Stratigraphy of India, 4th ed., New Age International (P) Limited, Publishers.
6. Lemon, R.R. (1990) Principles of Stratigraphy; Merrill Publishing Company, Ohio.
7. Prasad, C.V.R.K. (2005) Elementary Exercises in Geology; Universities Press (India) Pvt. Ltd, Hyderabad.
8. Ramakrishnan, M. and Vaidhyanadhan, R. (2010) Geology of India - Vol. 1, Geological Society of India, Bangalore.
9. Vaidhyanadhan, R. and Ramakrishnan, M. (2008) Geology of India - Vol. 2, Geological Society of India, Bangalore.
10. Wadia, D.N. (1984) Geology of India, 4th ed., Tata McGraw-Hill Publishing, New York.

Practical Course:

Stratigraphy and Geology of India, Maharashtra and Mumbai

I) Study of characteristic index fossils of a particular stratigraphic horizon.

II) Diagrammatic examples of Lithostratigraphic boundaries and classification.

III) Study of Geological maps with geological history of the area in chronological order.

IV) Problems:

a) Stratigraphic sequence from geological section.

b) Interpretation of depositional environments for stratigraphic sequences.

c) Stratigraphic Boundary Problem.

d) Understanding Phanerozoic Time Scale.

T.Y B.Sc. Geology **Course: S.Geo.6.02**

Title: Sedimentary Petrology

Learning Objectives:
To understand the various provenances, processes of formation and environments of deposition of sedimentary rocks.

Number of Lectures - 60

Unit 1: **(15 lectures)**

Introduction
Origin, transportation and deposition of sediments.
Classification of Sedimentary rocks
Basin, environment and facies concept.
Field techniques:
Sedimentary structures- Basic measurements and data records
Sketches and lithologs
Sediment interpretation in cores
Sedimentary Texture analysis:
Grain Size scales and laboratory methods of analysis
Shape analysis
Concept of maturity

Unit 2: **(15 lectures)**

Siliciclastic sedimentary rocks
Sandstones
Field observations
Petrography and classification
Heavy minerals and other provenance indicators
Concept of diagenesis and authigenesis
Conglomerates and breccia
Classification and field observations
Depositional environments for sandstones and conglomerates
Mudrocks:
Field Observations: Textures, Structures, Colour, Nomenclature
Laboratory Studies: Mineral composition and provenance.

Unit 3: **(15 lectures)**

Limestones and dolomites
Field Observations
Components and mineralogy of limestones
Classification of limestones and petrography
Carbonate diagenesis
Dolomitization and dedolomitization
Silicification of limestone
Carbonate depositional environments

Unit 4: **(15 lectures)**

Other Types of Sedimentary Rocks:

Evaporites-

Origin of Giant Evaporite Deposits

Palaeoclimatic interpretation from evaporites

Bedded Cherts and Phosphate Rocks- Origin, mineralogy and types

Coal and petroleum

Organic deposits- Modern and ancient

Coal petrology

Oil shales

Formation of Kerogen and Petroleum

Volcaniclastic sediments- Types and field characters.

List Of Recommended Books:

1. Collinson J.D and Thompson D.B (2006), Sedimentary Structures (2nd Edition),
2. Lindholm R.C. (1987), A practical approach to Sedimentology, Allen and Unwin, London.
3. Nichols, G. (2009), Sedimentology and stratigraphy (2nd Edition), Wiley India.
4. Pettijohn F.J. (1984), Sedimentary Rocks (3rd Edition), CBS Publishers and Distributors, New Delhi.
5. Staw, A.V.D (2005), Sedimentary rocks in the field: A colour guide, Manson Publishing, London.
6. Tucker, M. E (2001), Sedimentary Petrology (3rd Edition), Blackwell Science Ltd. Unwin Hyman Ltd, Sydney.

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Practical Course

Megascopic and Microscopic Identification of Sedimentary Rocks.

Sedimentary Textures. (Clastic)

Rudaceous (Conglomeratic/ Brecciatic), Arenaceous (Gritty/ Sandy), Argillaceous

Sedimentary Structures

1. Parallel bedding
2. Current Bedding
3. Graded Bedding
4. Ripple Marks
5. Rain Imprints
6. Concretions/Secretions

Grain size and shape analysis

Preparation of lithologs and sections

Paleocurrent analysis

Identification and description of heavy minerals

T.Y. B.Sc. Geology **Course: S.Geo.6.03**
Title: Engineering Geology

Learning Objectives: To understand the engineering properties of rocks and their use as construction material. Detailed study of various geological and geotechnical investigations for various civil engineering projects. To understand the impact of Geological activities on the environment.

Number of lectures: 60

Unit 1: **(15 lectures)**

Engineering Properties of Rocks:

Specific Gravity
Porosity
Sorption
Compressive Strength
Tensile Strength
Elasticity of Rocks
Residual Stress and Shear Stress in Rocks.

Engineering properties of soil

Soil classification
Soil gradation
Compressive and shear strength
Atterberg limits
Consolidation and swelling of clays

Unit 2: **(15 lectures)**

Rocks as Construction Materials:

Types of Rocks used in construction: How are they obtained in nature? Use of Rocks as facing stone. Factors influencing Engineering usefulness of Rocks.

Use of Rocks as aggregates: Use of rock as an aggregate in different types of constructions, sources of different grades of aggregates. Properties of aggregates (Shape, Size, Surface Texture, Roundness, Coating), Cement aggregate reaction, Thermal effects on aggregate. Highway aggregate, Rail – road ballast, Runway aggregate.

Source of Rock aggregate:

Types of quarries, Exploration for quarries, processing of aggregates.

Source of sand and gravel

Unit 3: **(15 lectures)**

Geological and Geotechnical investigations for Civil Engineering Projects:

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.

Landslides: Causes, types and prevention of landslides. Influence of divisional planes, effects of faults, Crushed zones.

Bridges: Classification, abutments, foundations, investigations for site selection.

Unit 4

Geological and Geotechnical investigations for Civil Engineering Projects:

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. Locations of all the important dams and Hydro – electric projects in India.

Dam failures-causes and case studies.

List Of Recommended Reference Books

Engineering Geology

1. Narayanswami S.B.S. (2000), Engineering Geology, Dhanpat Rai & Co, India.
2. Legget F. R and Hatheway A.W. (1988), Geology and Engineering., 3rd ed. McGraw-Hill.
3. Gupte R.B. (1992), A Textbook of Engineering Geology.2nd ed. Pune Vidyarthi Griha Prakashan.
4. Krynine D.P. And Judd W.R (2003), Principles of Engineering Geology and Geotechniques, CBS Publishers.
5. Wahlstrom E.E. (1974), Dams, Dam Foundations and Reservoir Sites. Elsevier Scientific.
6. Dunn I.S., Anderson L.R and Kiefer F.W. (1980), Fundamentals of Geotechnical Analysis, John Wiley.
7. Maslov N.N. (1987), Basic Engineering Geology and Soil Mechanics. Mir Publishers.
8. Gokhale K.V.G.K and Rao D.M. (1981), Experiments in Engineering Geology. Tata McGraw-Hill.

Practical Course:

Engineering Geology

- Geological maps to demarcate and evaluate the suitability of sites for engineering projects such as Tunnels, Dams and Reservoir construction.
- Correlation of borehole data.
- Determining uniaxial compressive strength of rocks.
- Equal-area net

a) Locus of rotating line
b) Determining core-pole angle and orientation of plane in recovered core
c) Determining slope stability
d) Determining orientation of bed in rotational fault

T.Y. B.Sc. Geology **Course: S.Geo.6.04**

Title: Photogrammetry, Aerial Photo Interpretation and Fundamentals of Geographical Information Systems

Learning Objectives:

1.To bring about an understanding of the principles of Photogrammetry and about the various analytical techniques used. To understand the construction and working of various instruments used in the process of aerial photo interpretation

2.Understand the principles of GIS and study its application in Earth Sciences.

Number of lectures: 60

Unit 1 **(15 lectures)**

Principles of Aerial Photography

Early history of aerial photography;
Aerial cameras, Film resolution.
Electronic Imaging, Aerial Videography.
Basic Geometric Characteristics of Aerial Photographs: Geometric types of Aerial Photographs, Taking Vertical Aerial Photographs, Geometric Elements of Vertical Photograph.
Photographic Scale.
Ground Coverage of Aerial Photographs.
Area Measurement on aerial photographs.

Unit 2 **(15 lectures)**

Principles of Photogrammetry:

Relief Displacement of Vertical Features in aerial photographs.
Characteristics of Relief Displacement,
Object height determination from Relief Displacement Measurement.
Correction for Relief Displacement.
Image Parallax: Characteristics of Image Parallax, Parallax Measurement.
Ground Control for Aerial Photography.
Mapping with Aerial Photographs: Stereoscopic Plotting Instruments, Orthophotos, Photogrammetric Work Stations.
Flight Planning.

Unit 3 **(15 lectures)**

Aerial Photo Interpretation:

Fundamentals of Visual Image Interpretation.
Basic Visual Image Interpretation Equipment- Construction and Working.
Land-use/Land cover mapping.
Geologic and Soil mapping.
Water Resource Applications.
Archaeological Applications.
Environmental Assessment
Principles of Landform Identification.

Unit 4 **(15 lectures)**

Basics of Geographical Information Systems

Definitions of GIS
The components of a geographical information system.
Basic requirements for a GIS.
Data Models: Conceptual models of real world geographical phenomena.
Conceptual models of space.
Geographical Data models: Vector models of Entities – Simple points, lines and polygons.
Raster Data Structures-The grid Cell Data Types: Boolean, Nominal, Ordinal, Integer, Real, Topological. Data Input: Sources of Geographical Data, Geographical data Collectors and providers.
Geo-referencing.

Reference Books:

1. Lillisand Thomas M., Ralph W. Kiefer and Jonathan W. Chapman, (2004), Remote Sensing and Image Interpretation, 5th ed., Wiley.
2. Jensen John R., (2007), Remote Sensing of the Environment – An Earth Resource perspective, 2nd ed. Pearson Education Series.
3. Linder Wilfried (2003), Digital Photogrammetry- Theory and Applications, Springer.
4. Ramasamy S.M. (2005), Remote Sensing in Geomorphology, New India Publishing Agency.
5. Misra R.P. and Ramesh A. (1999), Fundamentals of Cartography, 2nd ed., Concept Publishing Company. New Delhi.
6. Longley Paul A, Michael F. Goodchild, David J. Maguire and David W. Rhind (2005), Geographic Information Systems and Science, 2nd ed., Wiley
7. Nag P. and Sengupta Smita (2008), Introduction to Geographical Information System., Concept Publishing Company, New Delhi.
8. Burrough Peter A. and Rachael A. McDonnell (1998), Principles of Geographical Information Systems, Oxford University Press.
9. Chang K. (2002), Introduction to Geographical Information Systems, Tata McGraw-Hill Edition.
10. Morain Stan and Shirley Lopez Baros (ed.) (1996), Raster Imagery in Geographical Information Systems., Onward Press.
11. Davis Bruce E (1996), GIS – A Visual Approach., Onward Press.

Practical Course:

- Test and Exercise for Stereoscopic vision
- Determination of Photo Scale and numerical problems on photo scale.
- Orientation of Stereographic pair of aerial photographs under a mirror stereoscope and point transfer. Plotting of principal point, flight line and match line.
- Construction of stereogram
- Handling of a parallax bar and height calculation
- Numerical problems on height calculation using measured relief displacement on a single aerial photograph.
- Flight Planning: Calculations necessary to develop a flight plan and draw a flight map.

- Interpretation of aerial photographs: various landforms, erosion types , horizontally bedded sandstones, shale and limestone. Intrusive igneous rocks, extrusive (lava flows). Aeolian Landforms: transverse sand dunes, longitudinal sand dunes, loess. Glacial landforms: end moraine, basal moraine, drumlins, eskers. Fluvial Landforms: alluvial fans, deltas. Coastal landforms: beach ridges, beach cusps, dunes, surface expressions of anthropogenic activities.

T.Y. B.Sc. Geology **Course S.Geo 6.0 AC**
Title: Gemmology

Learning Objectives:
To study and understand the evolution of gemstones and gem materials

PREREQUISITE : Courses S.Geo.3.0 and S.Geo.4.0

Number of lectures: 60

Unit 1 **(15 lectures)**

The Geological Sources of Gems
Rocks and processes that formed them.
Gem regions. Gem recovery methods
Cryptocrystalline, massive and metamict states
Hardness**:** definition, Mohs' scale, Cleavage: definition, description, importance in gemmology and lapidary work
Specific Gravity: Definition, Heavy liquids (bromoform, methylene iodide, sodium polytungstate and Clerici solution)
Luminescence: Fluorescence and phosphorescence, photoluminescence and Stoke's law,
Thermal conductivity and thermal conductivity meter, 10 X lens, Chelsea colour filter

Unit 2 **(15 lectures)**

Optical Properties
Nature of colour: absorption of light, allochromatism, idiochromatism
Lustre, sheen, chatoyancy and asterism in gemstones, play of colour, dispersion, metamerism, use of, cross filter test.
Polarization and absorption of light
Nature and production of polarized light, design and construction of polariscope and its use in gemmology. Differential absorption of light, pleochroism, dichroscope, construction and use;
Spectroscope – construction and use, absorption spectra,
Reflection: laws of reflection, importance in gemmology.
Refraction: laws of refraction, refractive index, total internal reflection, use and design of refractometer, measurement of R.I. and birefringence by refractometer and other methods. Isotropism and Anistropism in gemstones, anomalous double refraction, optic axes

Unit 3 **(15 lectures)**

Fashioning of gemstones
Cutting styles, critical angle, composite stones, gemstone polishing, lapidary techniques and gemstone carving.
Diamonds: Diamond cutting and polishing methods, diamond grading including cut, colour, clarity and carat weight.
Diamond synthesis, thin diamond films, chemical vapour deposition (CVD)
Gemstone simulants: Glass, plastics, diamond simulants, assembled or composite stones
Metric carat, pearl grain, kilogram, gram, milligram, meter, millimeter, micrometer, nanometer, Angstrom, litre, milliliter

Unit 4 **(15 lectures)**

Gemstone synthesis and treatments

Methods of staining, heat treatment, diffusion treatment, fracture filling, cavity filling, coatings, dyeing, laser drilling, atomic irradiation and their detection

Synthesis of gemstones:

Methods of manufacture: flame-fusion (Vernueil), flux-melt, hydrothermal, crystal-pulling (Czochralski), skull-crucible method, zone melting.

Reference Books:

1. Gemmology (3rd edition) 2005 by P.G. Read.
2. Practical Gemmology (6th edition) 1976 by R. Webster.
3. Gem Testing (10th edition) 1990 by B. W. Anderson.
4. Gemstones of the world (4th edition) 2010 by Walter. Schumann.
5. Gems(5th edition) 1995 by Robert Webster (revised by B.W. Anderson)
6. Identification of gemstones (2003) by Michael O'Donoghue and Louise Joyner
7. Gems (6th edition) 2006 edited by Michael O'Donoghue.
8. A Handbook of gem identification (12th edition) by Richard T. Liddicoat
9. Gem Identification Made Easy by Antoinette L. Matlins and A.C. Bonanno.
10. Fluorescence Gems and Minerals under Ultraviolet Light 1994 by Manuel Robbins
11. Color Encyclopedia of Gemstones. (2nd edition) 1987 by Joel E. Arem.
12. Fluorescence Gems and Minerals Under Ultraviolet Light (1994) by Manuel Robbins
13. Gemstone Buying Guide How to evaluate, identify, select and care for colored gems by Renee Newman.
14. The complete encyclopedia of minerals (2001) by Petr Korbel and Milan Novak.
15. Collecting Fluorescent minerals (2004) by Stuart Schneider.

Practical Course:

Gem Properties and Characteristics

1. Specific gravity problems.
   a) Hydrostatic method, b) comparison of specific gravity of gemstones.
2. Refractive Indices problems
   a) Isotropic stones, b) Uniaxial stones, c) Biaxial stones.
3. Weight Estimation Problems
4. Problems on design, gemstone cuts.
   a) Light ray path through a profile of cut; b) facet patterns and facet tally of various types of cuts; c) cabochon cuts.
5. Procedures of distinguishing, different gemstones using a dichroscope, polariscope and a loupe, on the basis of their various physical and optical characters
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