St. Xavier’s College  
Mumbai  

Syllabus  
for B.Sc VI\textsuperscript{th} Semester Courses in Geology  
(November 2016 onwards)  

Contents:  
• Theory Syllabus for Courses:  
  o S.Geo.6.01 – Phanerozoic Geology of India  
  o S.Geo.6.02 - Sedimentary Petrology  
  o S.Geo.6.03 - Engineering Geology  
  o S.Geo.6.04 - Photogrammetry, Photo Interpretation & Fundamentals of GIS  
  o S.Geo.6.AC- Gemmology  
• Practical Course Syllabus for S.Geo.6.PR  
• Practical Course Syllabus for S.Geo.6.AC.PR  
• Evaluation and Assessment guidelines.
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:

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 (2\textsuperscript{nd} Edition),
3. Nichols, G. (2009), Sedimentology and stratigraphy (2\textsuperscript{nd} Edition), Wiley India.

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  

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:  
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:  
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.

Unit 3:  
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

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

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

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

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
Basics of Geographical Information Systems
(15 lectures)
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:

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.
T.Y. B.Sc. Geology  
**Title:** Gemmology  

**Course S.Geo 6.0 AC**

**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**

**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**

**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  
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**

**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**

**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:**

5. Gems(5th edition) 1995 by Robert Webster (revised by B.W. Anderson)
10. Fluorescence Gems and Minerals under Ultraviolet Light 1994 by Manuel Robbins

**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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