St. Xavier's College
Mumbai

Syllabus
for B.Sc Ist Semester Courses in Geology
(June 2017 onwards)

Contents:

F.Y. B.Sc. Geology **Course: S.Geo.1.01**
Title: Introduction To Mineralogy and Crystallography

Learning Objectives:
This is among the first exposure that a learner has to the subject of geology at the undergraduate level. The aim of this course is to develop in the learner,ability to understand and identify various minerals along with their characteristic crystallographic properties, as this forms one of the fundamental requirements in the later profession.

Number of lectures: 45

Unit 1
Mineralogy: **(15Lectures)**
Chemical bonds and formation of compounds.
Minerals: definition, chemical compositions and classification.
Physical properties of minerals: colour, streak, luster, diaphaneity, form, habit, cleavage, fracture, hardness, specific gravity, and electrical and magnetic properties.
Isomorphism, polymorphism and pseudomorphism.

Unit 2
Elementary Crystallography: **(15 Lectures)**
States of matter: crystalline state.
Elementary ideas about the crystal structure.
External characteristics of crystals: face, form, edge, solid angle, interfacial angle and its measurement, zone.
Crystal symmetry: planes, axes and center of symmetry.
Crystallographic axes and axial angles, parameters, indices and rational indices.
Classification of crystals into seven systems.
Study of the normal classes belonging to following systems:
Isometric, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic.

Unit 3
Descriptive Mineralogy of Rock forming minerals: **(15 Lectures)**
Structural classification of silicates.
Feldspars, Silica, Pyroxene, Amphibole, Mica, Olivine.

List Of Recommended Reference Books

1. Dana J.D. and Ford W.E. (rev. ed.) (2010), Dana's Manual of Mineralogy, J. Wiley & Sons.
2. Read H.H. (Rev. ed. C.D. Gribble) (1988), Rutley's Elements of Mineralogy" (27TH Edition), CBS Publications.
3. Perkins D (2010). Mineralogy (3rd Edition), Prentice-Hall of India.

Practical Course:
I. Study of crystal models representing forms of seven normal classes of symmetry.
II. Identification and description of the physical properties, composition, occurrences and uses of 30 rock forming minerals.

F.Y. B.Sc. Geology **Course: S.Geo.1.02**
Title: Introduction To Earth Science, Cartography And Structural Geology

Learning Objectives:
The primary platform for any learner attempting to understandgeology is our planet earth. As this course is among the introductory courses at the undergraduate level, it needs to communicate and also attempt at the learner becoming acquainted with the various theories about the origin of the universe and our solar system. After that the learner needs to know the theories that lead to the understanding about the planets interior and the energy systems that drive the various internal (sub-surface and deep interior) systems along with the linkages between the interior and the atmospheric circulation. This leads to an understanding about the internal and external processes on our planet and how various structures within rocks form due to earth's internal forces.

Number of lectures: 45

Unit-1: **15 Lectures**

Earth in the Solar System:
Geology and its perspectives.
Earth in the Solar System**:** Earth's Origin, size, shape, mass, density, rotational parameters.
Earth's Internal structure: core, mantle, and crust.
Hydrosphere, Atmosphere and Biosphere: characteristics and elemental abundance in each constituent. Convection in the earth's core and production of its magnetic field.
Age of the earth.

Unit-2: **15 Lectures**

Atmospheric circulation and Global climatic changes:
Atmospheric circulation, weather and climate changes.
Land-air-sea interaction.
Earth's heat budget and global climatic changes.
Ocean currents:
Generation of oceanic currents, surface currents and global ocean conveyor system.
Ocean as a thermostat for the earth's surface heat balance.
Cartography:
Maps and Topographical maps; latitude – longitude concepts, Datum, map projections, types of maps, SOI map index, Contours and contour reading: Scales and Compass bearings, map grids (UTM).

Unit-3: **15 Lectures**

Structural Geology:
Stratification; Dip and Strike; Clinometer compass its use.
Outcrop pattern of horizontal, dipping and vertical strata on various types of topography.
Outliers, Inliers.
Folds: Definition, Morphology, anticline and syncline.
Types of folds: symmetrical, asymmetrical, recumbent, overturned, isoclinal, plunging, doubly plunging, structural dome and basin, monocline, structural terrace, chevron, fan, anticlinorium, synclinorium, Importance of folds.

Joints: Definition, geometric classification and importance.
Faults: morphology; geometric classification based on relation to affected rocks, angle of dip, apparent movement and relative movement; distributive faulting: horst, graben and step faults; nappes.
Unconformities: nature, types and importance; overlap and off-lap.

List Of Recommended Reference Books

1. Compton R.R. (1985), Geology in The Field., J. Wiley& Sons
2. Skinner B.J., Porter S.C. and Botkin D.B. (1999), The Blue Planet., 2nd edn. J. Wiley & Sons.
3. Holmes A. (1993), Principles of Physical Geology.,ed by David Duff, Nelson Thornes Ltd
4. Billings M.P. (1987), Structural Geology., 3rd edn, Prentice-Hall, India Pvt. Ltd
5. Robinson. A, Morrison. J, Muehrcke. P, Kimerling. A, Guptill. S (1995),Elements of Cartography, 6 ed, J. Wiley & Sons.
6. Siddhartha K., (1999) , Oceanography - A Brief Introduction., KisalayaPubln., India
7. Butz S. (2007) Science of Earth Systems., 2nd edn., Thomas Delmar.

Practical Course:

I. Use of Clinometer and Brunton compasses
II. Description and drawing of vertical cross section of simple geological maps involving horizontal or dipping strata with vertical faults, folded (non-plunging and non-faulted) strata and strata involving angular unconformity.
III. Graphical solution of structural geology problems involving
    a. Strike, true dip and apparent dip
    b. Thickness and width of outcrop.

Evaluation and Assessment: S.Geo. 1.01 and 1.02 courses

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

Continuous Internal Assessment (CIA) - 40 marks

CIA 1: Written test -20 marks

CIA 2: One day Geological Field work around Mumbai with field report and viva on the fieldwork. -20 marks

End Semester Examination – 60 marks

One question from each unit for 20 marks, with internal choice. Total marks per question with choice -28 to 30.

Evaluation of S.Geo.1.PR (Practicals) Total marks for Practical course - 100.

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

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	10	06	04	20
2	10	06	04	20
3	10	06	04	20
-TOTAL - Per objective	30	18	12	**60**
% WEIGHTAGE	50	30	20	**100%**

St. Xavier's College, Mumbai **Course: S.GEO.1.01/1.02**

Department of Geology **Roll Number: _____**

UID Number:_____

MARKS:____/20

Date:_____

Assessment Grid for Course: S.GEO.1.01/1.02CIA 2 (Field Work)

Parameters Category	Details of Assessment	80 – 100 % Excellent	60 – 80 % Good	40 – 60 % Satisfactory	20 –40 % Poor	0 - 20 % Very Poor
Field Work (30 %)	1. Equipment – field diary, hammer, chisel, hand lens, map, Field discipline.(02)					
	2. Sample Collection and Instrument handling (01)					
	3. Prior Preparation (03)					
Field Report (60 %)	1. Field Diary (04)					
	2. Content, Presentation and Technical correctness (08)					
Viva Voce (10 %)	1. Ability to answer questions. (02)					
Total Marks/20						

Name, Signature of Course Instructor

Date:

St. Xavier's College
Mumbai

Syllabus
forBScIInd Semester Courses in Geology
(November 2017 onwards)

Contents:

F.Y. B.Sc. Geology **Course: S.Geo.2.01**
Title: Introduction to Petrology, Geotectonics and Economic Geology

Learning Objectives: As a part of the four formative courses which introduce the learner to the basics of geology, this module incorporates the necessarytopics to appreciate and understand the processes which lead to the formation of various rock types and mineral deposits along with their relationship to tectonism. A brief understanding of the methods of exploration and exploitation of earth's natural resources is also discussed.

Number of lectures: 45

Unit 1 **(15 lectures)**

Igneous Petrology

Rocks: definition, their classification.
Magma: definition, composition, origin, Bowen's Reaction Series, magmatic differentiation and assimilation.
Mode of occurrences, Intrusive and Extrusive forms.
Textures and structures.
Classification based on grain size and mineral composition.

Metamorphic Petrology

Metamorphism: definition, agents and types of metamorphism.
Metamorphic minerals: stress and anti-stress minerals, textures and structures.
Metamorphic facies and isograds, Relationship between metamorphism and deformation.
Rock cycle.

Unit 2 **(15 lectures)**

Sedimentary Petrology

Sediments: weathering, transport, deposition, consolidation, diagenesis.
Textures and structures.
Classification: Terrigenous and Chemical sedimentary rocks.

Mineral Deposits

Classification and brief study of following mineral deposits: Hydrothermal, Magmatic, Sedimentary (evaporites, strata-bound, bedded iron formations), Placer, Residual.

Unit 3 **(15 lectures)**

Introduction to Mineral Exploration and Mining:

Methods of mineral exploration: Surface methods – grid sampling. Sub-surface methods – Seismic, Electrical, Magnetic and Electrical.
Basic ideas about the methods of mining.

Geotectonics:

Earthquakes: causes, effects, tsunamis, measurement of earthquakes, seismic belts, seismic zonation in India.
Volcanoes: types, causes and distribution.
Origin of Mountains, Oceans and Continents.
General relief features of the ocean floor.

List Of Recommended Reference Books

1. Ehlers, E.G. and H. Blatt (1982), Petrology, Igneous, Sedimentary and Metamorphic, W.H Freeman, San Francisco
2. Tyrell G.W. (1980), Principles of Petrology: An Introduction to the Science of Rocks., 1st Indian Edn., B.I. Publn. India.
3. Ramam P.K. (1989), Principles and Practices of Mineral Exploration.,Publ. Geol. Soc. Ind.
4. Arogyaswami R.N.P. (1973), Courses in Mining Geology., Oxford & IBH
5. Agoskhov M., Borisov S., Layansky V. (1888), Mining of Ores and Non-metallicMinerals., Mir Publishers

Practicals

I. Identification of group characteristics of 25 common rocks and their classification into major rock groups. Identification and systematic description of the megascopic features of these rocks.

II. Identification and description of the physical properties, composition, occurrences of 10 commonly occurring economic ore minerals.

F.Y. B.Sc. Geology **Course: S.Geo.2.02**

Title:

Introduction to Physical Geology, Principles of Stratigraphy and Paleontology

Learning Objectives:

As the fourth module in the introductory courses in geology, the learner is exposed to the now accepted modern day concept of plate tectonics, which also explains the various surface features on our planet. The learner develops an understanding about the various surface phenomenon that lead to the development of soild and the breakdown of landforms. The last unit in this module introduces the learner to the basics of stratigraphy, whereby the concept of age related geological activities which shaped our planet are explained. Also explained is the basis of formation of fossils.

Number of lectures: 45

Unit 1 Introduction to Plate Tectonics and Physical Geology (15 Lectures)

Theory of Plate Tectonics and its proofs .

Introduction to Weathering and Erosion; Exogenic and endogenic geomorphic processes; Evolution of landscape.

Soil: definition, formation and functions; soil profile.

Unit 2 Landforms (15 Lectures)

Wind:erosion, transport and deposition; Aeolian landforms.

Rivers: development of a typical river system; erosion, transportation and deposition; Fluvial landforms

Glaciers**:** types, formation and morphology; erosion, transport and deposition; Glacial landforms.

Oceans: marine erosion and deposition; Coastal landforms.

Unit 3 Introduction to Principles of Stratigraphy and Paleontology (15 Lectures)

Definition of stratigraphy.Nature of stratigraphic records.

Principles of Stratigraphy- superposition, initial horizontality, lateral continuity, floral and faunal succession, cross-cutting relationship, and uniformitarianism.

Concept of time in geology.Geological time scale.Unconformities- types, formation and applications.

Introduction to paleontology.Fossils- definition, types of fossils, modes of preservation.Applications of fossils in geology.

List Of Recommended Reference Books

1. Benton M.J. and Harper D.A.T. (2009), Introduction to Paleobiology and Fossil Record, Wiley-Blackwell Publication.
2. Ray Anis. K, (2008), Fossils in Earth Sciences, Prentice Hall of India
3. Butz S. (2007) Science of Earth Systems., (2nd Edition), Thomas Delmar.
4. Dasgupta, A.,(2005), Introduction to Palaeontology, (1st Edition), World Press
5. Skinner B.J., Porter S.C. and Botkin D.B. (1999), The Blue Planet.,(2nd Edition) J. Wiley & Sons.

6. Holmes A. (1993), Principles of Physical Geology.,ed by David Duff, Nelson Thornes Ltd
7. Emiliani C. (1992), Planet Earth: cosmology, geology and evolution of life and environment, Cambridge University Press.
8. Weller J.M. (1960), Stratigraphic Principles and Practice, Harper.

Practicals

1. Study of 3D models of the various landforms formed due to the geomorphic processes.
2. Preparation and Correlation of the lithologs, and their interpretations.
3. Mode of preservation of fossils

Evaluation and Assessment: S.Geo. 2.01 and 2.02 courses

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

Continuous Internal Assessment (CIA) - 40 marks

CIA 1: Written test -20 marks

CIA 2: One day Geological Field work around Mumbai with field report and viva on the fieldwork. -20 marks

End Semester Examination – 60 marks

One question from each unit for 20 marks, with internal choice. Total marks per question with choice -28 to 30.

Evaluation of S.Geo.1.PR (Practicals) Total marks - 100.

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

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	10	06	04	20
2	10	06	04	20
3	10	06	04	20
-TOTAL - Per objective	30	18	12	**60**
% WEIGHTAGE	50	30	20	**100%**

St. Xavier's College, Mumbai **Course: S.GEO.2.01/2.02**

Department of Geology **Roll Number: _____**

UID Number:_____

MARKS:____/20

Date:_____

Assessment Grid for Course: S.GEO.2.01/2.02CIA 2 (Field Work)

Parameters Category	Details of Assessment	80 – 100 % Excellent	60 – 80 % Good	40 – 60 % Satisfactory	20 –40 % Poor	0 - 20 % Very Poor
Field Work (30 %)	1. Equipment – field diary, hammer, chisel, hand lens, map, Field discipline.(02)					
	2. Sample Collection and Instrument handling (01)					
	3. Prior Preparation (03)					
Field Report (60 %)	1. Field Diary (04)					
	2. Content, Presentation and Technical correctness (08)					
Viva Voce (10 %)	1. Ability to answer questions. (02)					
Total Marks/20						

Name, Signature of Course Instructor

Date:

St. Xavier's College
Mumbai

Syllabus
forB.Sc IIIrd Semester Courses in Geology
(June 2017 onwards)

Contents:

S.Y. B.Sc. Geology **Course: S.Geo.3.01**
Title: Stratigraphy, General and Invertebrate Palaeontology

Learning Objectives: Among the first of the core courses, developed keeping in mind the needs of a professional geologist and a learner who is likely to pursue his career in the subject, this course communicates the basis of stratigraphy and correlation of strata among rock sequences. The correlation between the rocks and the evolving life on our planet is dealt with in two units. They specifically deal with the characteristic features, origin, evolution and preservation of life in sedimentary rocks.

Number of lectures: 45

Unit 1 Stratigraphy **(15 lectures)**

Stratigraphic classification & nomenclature, study of stratigraphic elements, Stratigraphic Units: lithostratigraphic, geochronologic, chronostratigraphic and biostratigraphic.
Concept of biozones and applications of biostratigraphic units.
Walther's law of facies and its application in the field.
Introduction to sequence stratigraphic.

Unit 2 Paleontology - I **(15 lectures)**

Modern concept of origin of life, principles and theories of evolution, mechanism & pattern of evolution; causes of migration, dispersal and extinction of organisms, Mass extinctions
Introduction to paleontology, Potential and preservation of fossils, Types and applications of fossils
Taphonomy
Study of functional morphology and evolutionary trends of:
-Trilobite
-Brachiopoda
Importance of Dinosaur fossils in India
Evolution of Horse and Elephant.

Unit 3 Paleontology-II **(15 lectures)**
Study of functional morphology and evolutionary trends of:
-Mollusca: Pelecypoda, Gastropoda, and Cephalopods
-Corals
-Echinoidea
-Graptololoidea
Ichnofossils: introduction, types and applications in paleoenvironmental interpretation.

List Of Recommended Reference Books

1. Benton M.J. and Harper D.A.T. (2009), Introduction to Paleobiology and Fossil Record, Wiley-Blackwell Publication.
2. Nichols G. (2009), Sedimentology and Stratigraphy, Wiley-Blackwell.
3. Ray Anis. K, (2008), Fossils in Earth Sciences, Prentice Hall of India.
4. Catuneanu O. (2006), Principles of Sequence Stratigraphy, Elsevier.
5. Dasgupta, A., (2005), Introduction to Palaeontology, (1st Edition), World Press.

6. Kumar R. (1996), Fundamentals of Historical Geology and Stratigraphy of India, 4th ed., New Age International Limited.
7. Clarkson E. (1993), Invertebrate Paleontology and Evolution, Chapman and Hall.
8. Raup D. and Stanley S.M. (1971), Principles of Paleontology, W.H. Freeman.
9. Shrock Robert R. and Twenhofel William H. (1953), Principles of Invertebrate Paleontology, McGraw Hill Co., New York.
10. Spencer E.W. (1962), Basic Concepts of Historical Geology, Thomas Y. Crowell, New York.
11. Weller J.M. (1960), Stratigraphic Principles and Practice, Harper.
12. Woods H (1958), Paleontology-Invertebrate, University Press London.

Practicals

1. Identification (morphology, classification, and geological distribution) and study of evolutionary trends of: trilobite, brachiopods, lamellibranches, gastropods, cephalopods, echinoids, and graptolites.
2. Identification and interpretation of biozones in stratigraphy.
3. Introduction to the identification of micro fossils.

S.Y. B.Sc. Geology **Course: S.Geo.3.02**
Title: Crystallography

Learning Objectives:
The aim of the course is to communicate and facilitate the understanding of concepts of crystal structures, symmetry and point groups. The course is also aimed to relate the application of crystallography in various fields with special emphasis on mineralogy. This course becomes the prerequisite to advanced level (S.Geo.5.0 courses) in petrology and gemology.

Number of lectures: 45

Unit 1:
Characteristic of Crystals: (15 lectures)
Atomic arrangement in crystals, Bravais Lattices, Crystal symmetry, Elements of symmetry: Planes, Axes and Centre, Axis of inversion symmetry, Crystallographic axes, Miller Indices, Axial ratios, Classification of crystals, Stereographic projections of symmetry, Graphical symbols used in stereographic illustrations.

Unit 2:
The thirty-two crystal classes and possible forms of each class (15 Lectures)
Forms and crystal morphology, Name of forms, Illustration and description of forms, open forms and closed forms, point groups and crystal systems, Derivation of 32 classes of symmetry with Hermann-Mauguin symbols, Characteristic symmetry, and relationships between crystal axes and symmetry notation of crystal systems.

Unit 3:
X-ray Diffraction and Crystal imperfections (15 Lectures)
Twin crystals, Twin axis, Twin plane, Composition plane. Types of Twinning: Simple and Multiple contact twins, Simple and Multiple penetration twins, Cyclic twins, Twinning in Feldspars: Carlsbad, Manebech, Baveno, Albite, Albite-Carlsbad.
X-ray Diffraction: Brief introduction of X-rays, Diffraction effects and Bragg equation, Application of X-rays in crystallography and mineralogy.

List Of Recommended Reference Books

1. Read H.H. (Rev. ed. C.D. Gribble) (1988), Rutley's Elements of Mineralogy" (27TH Edition), CBS Publications.
2. Cornelius K. and Hurlbut Jr. S. (1994), Manual of Mineralogy, Twenty first Edition and Minerals and Rocks Exercises in Crystallography, J. Wiley & Sons.
3. Dana J.D. and Ford W.E. (rev. ed.) (2010), Dana's Manual of Mineralogy, J. Wiley & Sons.
4. Rogers A.F. and Kerr P.F. (1942), Optical Mineralogy (2nd Edition), McGraw- Hill Co. Inc., New York.
5. Berry L.G., Mason B.H. and Dietrich R.V. (1983), Mineralogy, concepts, descriptions, determinations, W.F. Freeman and Co.
6. Deer W.A., Howie A.H. and Zussman J. (1992), An introduction to rock forming minerals, Longman Scientific and Technical.
7. Shelly David (1985), Optical Mineralogy (2nd Edition), Elsevier.
8. Nesse W.D. and Schulze D.J. (2004), Introduction to Optical Mineralogy" (Third Edition) and An Atlas of Minerals in Thin Section, Oxford University Press.

9. Perkins Dexter (2011), Mineralogy (International Edition), Pearson Education.
10. Wenk H.R. and Bulakh A. (2004), Minerals: their constitution and origin, Cambridge University Press.

Practicals:

Study of Symmetry: Symmetry elements of 32 classes of symmetry
Stereographic projections of Symmetry elements of 32 classes of symmetryStudy of 48 possible forms in crystallography with special emphasis on crystals belonging to the following Fourteen classes of symmetry:
Cubic system: galena, tetrahedrite& pyrite classes
Tetragonal system: zircon, chalcopyrite, nickel sulfate classes
Hexagonal system: beryl, apatite & beta- quartz classes.
Trigonal system: calcite, tourmaline and alpha- quartz classes.
Orthorhombic system: barite class.
Monoclinic system: gypsum class.
Triclinic system: axinite class.

Study of Twin-axis, Twin plane and composition plane of the following types of Twin crystals: Simple contact twinning: Spinel, Rutile, Aragonite, Gypsum, Augite, Orthoclase (Bavano, Manebach, Carlsbad).
Simple penetration twinning: Staurolite, Augite, Orthoclase (Carlsbad-partially penetrant).
Multiple contact twinning: Albite.
Multiple penetration twinning: Fluorite, Diamond (Star), Chrysoberyl (Wheel).
Multiple cyclic twinning: Aragonite, Chrysoberyl (Wheel).

S.Y. B.Sc. Geology **Course: S.Geo.3.03**
Title: Geomorphology and Cartographic Analysis

Learning Objectives:
Understanding of -

- **Concepts of Geomorphology & Cartography**
- **Types & Origin of Landforms**
- **Cartographic Techniques, their applications & interpretations**

Number of lectures: 45

Unit 1: **(15 lectures)**

Concepts of Geomorphology:
Energy for landform change, methods of dating.
Geomorphic Systems: people as Geomorphic Agents, People as creators of Landforms.

Structure controlled Landforms:
Landforms controlled by various structures like faults and folds and resulting peculiarities of drainage patterns

Volcanogenic landforms :
Energy of volcanic eruptions, Products of Volcano, Types of Volcanoes, Types of Eruptions, Landforms produced by Erosion of Volcanic features

Landforms controlled by predominantly Weathering process:
Landforms produced by weathering and the various processes that lead to the formation of Corestones, Tors, Pits, Pans, Caverns, Rills, Duricrust.

Landforms resulting from fluvial processes:
Concept of Fluvial Transport and Deposition, Formation of Alluvial Fans, Floodplains and Terraces, Alluvial river channels, Alluvial Bars, Braided Channels, Straight and Meandering Channels.

Unit 2: **(15 lectures)**

Eolian Processes and Landforms:
Landforms resulting from Eolian Erosion, Transport and Deposition.

Coastal Processes and resulting Landforms:
Erosional landforms of the coast.Depositional landforms of the coast.
Influence of Current rates of Erosion, Climatic influences past and present, Sea level changes.

Karst Processes and resulting Landforms:
Limestone Solution and erosion rates.
Surface landforms in karst terrain, Minor solution Sculpture, Enclosed Depressions.
Karst landforms of fluvial erosion, Underground water, caves and springs.

Glaciers and resulting Landforms:
Ice Movement, Flow patterns, Forms of Glacier surfaces, Erosional and depositional landforms.

Unit 3: **(15 lectures)**

Topographic Analysis:
Topographical profiles, Projected profiles, Superimposed profiles, Spur Profiles, Cross Valley Profiles, Geomorphological Mapping Using I.G.U symbols.

Slope Analysis:
Morphological Mapping by Savigear's Method.Average Slope Map, Generalized Contour Map.

Drainage Basin Analysis:
Drainage Basin as a Unit of Study. Discharge of Water from a Watershed, Hydrograph Shapes, Flood Frequency, Patterns of Discharge. Drainage basin morphometry – Linear and areal aspects.

References:

1. Wilson J.P. and Gallant J.C. (ed) (2000), Terrain Analysis Principles and Applications, John Wiley.
2. Saha P. and Basu P. (2004), Advanced Practical Geography - A laboratory Manual.,Books and Allied (P) Ltd. Kolkata, India
3. King .C.A.M., (1967) Techniques in Geomorphology., Edward Arnold, London.
4. Misra R.P. and Ramesh A. (1989), Fundamentals of Cartography, Concept Publ. India.
5. Morisawa M. (1985), Rivers - Form and Process, Longman Publ.
6. Doornkamp J.C. and King C.A.M. (1971), Numerical Analysis in Geomorphology - an Introduction, Butler and Tanner, London.
7. Selby M.J. (1985), Earth's Changing Surface - An Introduction to Geomorphology, Oxford University Press.
8. Zavoianu I. (1985),Morphometry of Drainage Basins, Elsevier.
9. Mitchell C.W (1973), Terrain Evaluation, Longman
10. Judson S. and Kauffman M.E. (1990), Physical Geology, 8th edn.Prentice Hall
11. Robinson A. H,Sale R.D. and Morrison J.L. (1978), Elements of Cartography, 4th ed. John Wiley.

Practicals:

1. Measurement of lengths, and areas enclosed within curves. (1 session)
2. Projected Profiles, Superimposed Profiles and interpretation(1 session)
3. Longitudinal, Cross valley Profiles and interpretation(1 session)
4. Generalised contours, Altimetric frequency and interpretation (1 Session)
5. Drainage basin delineation on topographical map, Ordering streams using Strahlers scheme. (1 session)
6. Linear Aspects (Stream number, bifurcation ratios, weighted mean bifurcation ratios, regression of stream numbers vs. order) (1 session).
7. Linear aspects(stream lengths, length ratios and regression of stream lengths vs. order) (1 session)
8. Areal aspects – (delineating lower order basins and measuring the area of each, order wise and regression of basin areas vs. order) (1 session)
9. Hypsometric analysis (2 session)
10. Hypsometric analysis

11. Geomorphic mapping using IGU symbols (2 sessions)
12. Geomorphic mapping using IGU symbols

Evaluation and Assessment: S.Geo. 3.01, 3.02, 3.03 courses

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

CIA- 40 marks

CIA 1: Written test -20 marks

CIA 2: Oral Presentation/MCQ/Assignment/fieldwork with field report- 20 marks

End Semester Examination – 60 marks

One question from each unit for 20 marks, with internal choice. Total marks per question with choice -28 to 30.

Evaluation of S.Geo. 3.PR (Practicals) Total marks - 150.

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Template for evaluation of S.Geo courses End Semester examination in Semester 3

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	10	06	04	20
2	10	06	04	20
3	10	06	04	20
-TOTAL - Per objective	30	18	12	**60**
% WEIGHTAGE	50	30	20	**100%**

Note: Template for S.Geo - CIA 2: Oral Presentation in Semester 3 - As per standard template approved by the Academic Board.

Field work and field report evaluation as per approved evaluation grid given herewith.

St. Xavier's College, Mumbai **Course: S.GEO.3.01/3.02/3.03**

Department of Geology **Roll Number: _____**

UID Number:_____

MARKS:____/20

Date:_____

Assessment Grid for Course: S.GEO.3.01/3.02/3.03CIA 2 (Field Work)

Parameters Category	Details of Assessment	80 – 100 % Excellent	60 – 80 % Good	40 – 60 % Satisfactory	20 –40 % Poor	0 - 20 % Very Poor
Field Work (50 %)	• Equipment – field diary, hammer, chisel, hand lens, map, Field discipline. • Sample Collection and Instrument handling • Prior Preparation, • Field Diary and viva.					
Field Report (50 %)	• Content, Presentation and Technical correctness					
Total Marks/20						

Name, Signature of Course Instructor

Date:

St. Xavier's College
Mumbai

Syllabus
forB.ScIVth Semester Courses in Geology
(November 2017 onwards)

Contents:

S.Y. B.Sc. Geology **Course: S.Geo.4.01**
Title: Economic Geology

Learning Objectives: To understand the fundamentals processes involved in the formation and distribution of various ore deposits.

Number of lectures: 45

Unit 1 **(15 lectures)**

Introduction to economic mineral deposits

Introduction, definition of metalliferous and non-metalliferous deposits, ore mineral, gangue, tenor of ore, industial minerals, overburden and country rock.

Classification of economically important metalliferous and non-metalliferous mineral deposits.Stratabound and stratiform ore deposits.

Structural and stratigraphic controls on mineralization, metallogenic epochs and provinces.

Ore genesis -I

Processes of formation of mineral deposits.

Magmatic concentration (early and late magmatic mineral deposits)

Sublimation and pegmatitic deposits

Unit 2 **(15 lectures)**

Ore genesis -II

Hydrothermal processes, cavity filling and metasomatism:

Hydrothermal processes: Principle, character of solution, types of openings in rocks, factors affecting deposition from hydrothermal solutions, wall rock alterations.

Cavity filling deposits: processes of formation and characteristic features of: fissure veins and its types (in brief), stock work, saddle veins, ladder veins, pitches and flats, breccia filling deposits, solution cavity fillings.

Contact Metasomatic Deposits: definition, criteria of replacement, resulting mineral deposits.

Sedimentation deposits, Metamorphic deposits

Evaporation deposits: brief account of non-metallic deposits of ocean water, lake water, ground water and hot springs.

Residual deposits: conditions favouring formation of residual deposits.

Mechanical concentration: principles and processes of formation of placer deposits (eluvial, alluvial, beach and aeolian).

Unit 3 **(15 lectures)**

Ore genesis - III

Oxidation and solution in the zone of oxidation, ore deposits in the zone of oxidation.

Supergene sulphide enrichment: requirements for supergene sulphide deposition, recognition of sulphide enrichment. Gossans and cappings, role of iron gossans, limonite and false gossans.

List of recommended reference books

1. Jensen M.R. and Bateman A.M. (1981), Economic mineral deposits, John Wiley & Sons.
2. Evans A.M. (1993), Ore geology and Industrial minerals, Blackwell Science.
3. Prasad U. (2000), Economic Geology - Economic Mineral Deposits, 2nd ed., CBS, India.

4. Jill R. (2015), Chemical Fundamentals of Geology and Environmental Geoscience, Wiley Blackwell. (forpracticals)

Practicals

Identification (with the help of physical properties), chemical composition, origin and Indian occurrences of Ore minerals and Industrial minerals of following minerals.

Barite
Bauxite
Biotite
Calcite
Chalcopyrite
Chromite
Cuprite
Dolomite
Fluorite
Galena
Garnet
Graphite
Gypsum
Hematite
Ilmenite
Kyanite
Limonite
Magnesite
Magnetite
Malachite
Marble
Muscovite
Psilomelane
Pyrite
Pyrolusite
Serpentine
Sphalerite
Stibnite
Talc
Tourmaline

Distribution of mineral deposits

Formation, association and Indian distribution of following ore minerals: Mica, Copper, Manganese, Lead and Zinc, Bauxite, Chromite, Gold

Numerical on Radiometric dating

Numerical on Ore reserve estimation

S.Y. B.Sc. Geology **Course: S.Geo.4.02**
Title: Optical Mineralogy and Systematic Mineralogy

Learning Objectives:
To introduce the basic concept needed to understand the optical mineralogy and to learn the physical and optical properties and characteristics of common rock forming minerals.
Number of lectures: 45

Unit 1 **(15 Lectures)**
Optical Properties of Minerals:
Nature and behaviour of light: Non-polarised and Polarised light, Refraction and Refractive index, Double refraction, Nicol prism and Filter poloroid, Isotropic and Anisotropic substances, Polarizing Microscope: Its Construction and Working.

Optical characteristics: Relief, Becke's test, Twinkling, Pleochroism, Birefringence, Polarization colours, Newton's scale, Extinction and Extinction angle, Anomalous polarization colours, Uniaxial and Biaxial minerals, Optical indicatrix, Interference figures, Optic sign, Sign of elongation, Use of Quartz wedge, Mica plate and Gypsum plate.

Unit 2 **(15 Lectures)**
Systematic Mineralogy: part I
Stability relationships, Condition of formation, Crystallography, Physical and optical properties, Composition and structure, Diagnostic Features, Occurrence and Uses of:
Silica Group
Feldspar Group
Feldspathoid Group
Mica Group

Unit 3 **(15 Lectures)**
Systematic Mineralogy: part II
Stability relationships, Condition of formation, Crystallography, Physical and optical properties, Composition and structure, Diagnostic Features, Occurrence and Uses of:
Amphibole Group
Pyroxene Group
Olivine Group
Garnet Group
Zeolite Group
Clay minerals

List Of Recommended Reference Books

11. Read H.H. (Rev. ed. C.D. Gribble) (1988), Rutley's Elements of Mineralogy" (27TH Edition), CBS Publications.
12. Cornelius K. and HurlbutJr. S. (1994), Manual of Mineralogy, Twenty first Edition and Minerals and Rocks Exercises in Crystallography, J. Wiley & Sons.
13. Dana J.D. and Ford W.E. (rev. ed.) (2010), Dana's Manual of Mineralogy, J. Wiley & Sons.

14. Kerr P.F. (1977), Optical Mineralogy (4th Edition), McGraw- Hill Co. Inc., New Delhi.
15. Berry L.G., Mason B.H. and Dietrich R.V. (1983), Mineralogy, concepts, descriptions, determinations, W.F. Freeman and Co.
16. Deer W.A., Howie A.H. and Zussman J. (1992), An introduction to rock forming minerals, Longman Scientific and Technical.
17. Shelly David (1985), Optical Mineralogy (2nd Edition), Elsevier.
18. Nesse W.D. and Schulze D.J. (2004), Introduction to Optical Mineralogy" (Third Edition) and An Atlas of Minerals in Thin Section, Oxford University Press.
19. Perkins Dexter (2011), Mineralogy (International Edition), Pearson Education.
20. Wenk H.R. and Bulakh A. (2004), Minerals: their constitution and origin, Cambridge University Press.

Practicals:

Mineralogy:

Study of Physical and Optical characters, mode of formation and occurrence in Rock types of the following :

Igneous rock forming minerals: Quartz, Orthoclase, Microcline, Albite, Labradorite, Leucite, Nepheline, Sodalite, Muscovite, Biotite, Hornblende, Augite, Aegirine, Hypersthene, Olivine, Tourmaline and Apatite.

Metamorphic rock forming minerals: Garnet, Staurolite, Chlorite, Talc, Serpentine, Actinolite, Tremolite, Anthophyllite, Epidote, Andalusite, Kyanite, Sillimanite, Calcite, Dolomite, Asbestos, Chrysolite, Magnesite.

Study of Physical properties, mode of occurrence and conditions of origin of the following Secondary minerals: Quartz (Rock crystal), Amethyst, Calcite (Rhombohedral, Scalenohedral& Nail-head spar), Stilbite, Scolecite, Mesolite, Chabazite, Laumontite, Apophyllite (Prismatic & Pyramidal), Gyrolite and Okenite.

S.Y. B.Sc. Geology **Course: S.Geo.4.03**
Title: Field Geology and Hydrogeology

Learning Objectives:
Understanding of construction & working of field equipment, Outcrops observations, measurements, recordings & interpretations and Hydro geological concepts, exploration, exploitation & recharge of groundwater.

Number of lectures: 45

Unit 1 **(15 Lectures)**

Nature of Geologic Surveying:
Uses of geologic surveying, Diversity of Surveys, Scope of geological field-work.
Study of Outcrops, Importance of Contacts and Discrimination between different types of contacts.Discrimination of Strike and Dip.
Topographical Maps (SOI) - Map Index and Map Scale, Map folding, map reading. Study of Geological Maps and understanding Map Symbols.
Field Observations: Schedule for Field Observations. General Suggestions for Field work: Beginning a field problem. Collecting and trimming samples. Taking photographs.

Data recording and mapping in various terrains
Lava flow mapping- Mapping in igneous terrains
Field observations of sedimentary rocks
Data recording for structurally complicated terrains- foliations and lineations

Methods of Geologic Mapping:
Method of reconnaissance mapping – Contact mapping on topographical map, Tape and Compass, Detailed geological mapping using Plane Table survey.
Mapping of horizontal contacts using Altimeter: Its construction and use.

Unit 2 **(15 lectures)**

Ground Water:
Definition, Utilisation, Hydrogeologic Cycle, Subsurface movement of water, Zones of Groundwater.Definition of Watertable.Types of Aquifers.Presentation of Water Level data on Maps and Graphs.Natural and Artificial Discharge of Groundwater. Springs.

Occurrence of Groundwater:
Origin of groundwater.Rock properties affecting groundwater.Vertical distribution of groundwater.Geological formations as aquifers.

Groundwater Movement:
Darcy's Law, Coefficient of permeability.Groundwater flow rate.Laboratory and field measurements of permeability. Tracing groundwater movements. Groundwater flow-lines and flow-nets.

Unit 3 **(15 lectures)**

Surface Investigations for Groundwater:
Conventional methods – surface indicators of ground water, biological indicators , Test-drilling.

Geophysical log in ground water exploration:
Resistivity logging, Potential logging, Temperature logging.

Geophysical exploration for ground water:
Resistivity method and Seismic method.

Ground water recharge:
Artificial Recharge of Groundwater: Concept. Methods. Water Spreading, rain water harvesting.
Waste water reused. Recharge mounds. Induced recharge.

List of recommended reference books

12. Coe, A.L (Ed) (2010) Geological field techniques, Wiley-Blackwell
13. Compton R.R. (1985), Geology in the Field., John Wiley and Sons.
14. Gokhale N.W. (2009), A Guide to Field Geology, CBS Publ. India
15. Berkman D.A. (1987), Field Geologists' Manual.,Monograph Series 9., The Australasian Institute of Mining and Metallurgy, Victoria, Australia.
16. Mathur S.M. (2001), Guide to Field Geology., PHI Learning., India.
17. Todd D.K. (1980), Groundwater Hydrology, 2nd ed. John Wiley.
18. Bouwer H. (1978), Groundwater Hydrology., McGraw-Hill
19. Chorley R.J. (ed) (1969), Introduction to Geographical Hydrology.,Metheun.

Practicals:
Calculation of true and apparent dip
Calculating rake and plunge of lineation
Plotting geological map and outcrop completion
Flow Nets.
Problems on permeability, porosity and rate of flow.
Water table contour map and its application

Evaluation and Assessment: S.Geo. 4.01, 4.02, 4.03 courses

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

CIA- 40 marks

CIA 1: Written test -20 marks

CIA 2: Fieldwork -20 marks

(This will be for all the three courses, that is 20 marks each, 3 days outside Mumbai City)

End Semester Examination – 60 marks

One question from each unit for 20 marks, with internal choice. Total marks per question with choice -28 to 30.

Evaluation (Practicals) Total marks for Practical course - 150.

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Template for evaluation ofS.Geo courses End Semester examination in Semester 4

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	10	06	04	20
2	10	06	04	20
3	10	06	04	20
-TOTAL - Per objective	30	18	12	**60**
% WEIGHTAGE	50	30	20	**100%**

Evaluation of fieldwork as per approved grid given below.

St. Xavier's College, Mumbai

Department of Geology

Course: S.GEO.4.01/4.02/4.03

Roll Number: _____

UID Number:_____

MARKS:____/20

Date:

Assessment Grid for S.GEO.4.01/4.02/4.03 CIA 2 (Field Work)

Parameters Category	Details of Assessment	80 – 100 % Excellent	60 – 80 % Good	40 – 60 % Satisfactory	20 –40 % Poor	0 - 20 % Very Poor
Field Work (50 %)	• Equipment – field diary, hammer, chisel, hand lens, map, Field discipline. • Sample Collection and Instrument handling • Prior Preparation, • Field Diary and viva.					
Field Report (50 %)	• Content, Presentation and Technical correctness					
Total Marks/20						

Name, Signature of Course Instructor

Date:

St. Xavier's College
Mumbai

Syllabus
ForB.ScVth Semester Courses in Geology
(June 2017 onwards)

- Contents:
- Theory Syllabus for Courses:
    - S.Geo.5.01 –Precambrian Geology of India
    - S.Geo.5.02 – Igneous Petrology
    - S.Geo.5.03 - Structural Geology
    - S.Geo.5.04 –Metamorphic Petrology
    - S.Geo.5.AC- Remote Sensing and Image Interpretation
- Practical Course Syllabus for: S.Geo.5. PR and S.Geo.5.AC.PR
- Evaluation and Assessment guidelines.

T.Y. B.Sc. Geology **Course: S.Geo.5.01**
Title: Precambrian Geology of India

Learning Objectives:
1. To bring about an understanding of the principals of Stratigraphy.
2. Understand the Precambrian Stratigraphy of India.

Number of lectures: 60

Unit 1

Introduction (15 lectures)

Earth's Crustal Structure and Tectonic framework of India- Cratons.
Tectonic Elements of Continents & Oceans.
Tectonic Divisions of India.
Indian Cratons:
DharwarCraton,
BastarCraton,
AravalliCraton

Unit 2

Cratons and Mobile Belts (15 lectures)

SinghbhumCraton
Proterozoic Eastern Ghat Mobile Belt
- Marginal & Transition Zone
- Western Charnockite Zone
- Western & Eastern Khondalite Zone.

Satpura Mobile Belt
- Central Indian Tectonic Zone

Sausar, Mahakoshal&BetulSupracrustal Belts

Unit 3

Proterozoic History **(15 lectures)**

Proterozoic Sedimentary Basins:
- Vindhyan Basin,
- Delhi Basin

Cuddapah& Kurnool Basins.
- Kaladgi Basin.
- Kolhan Basin

Unit 4

Precambrians of Extra – Peninsula (15 lectures)

Precambrian of Himalaya (Lesser & Higher Himalayas)

Precambrian of the Tethyan Basement
- Salkhala Group
- Vaikrita Group
- Jutogh Group
- Daling Group

Precambrians of the Lesser Himalaya
- Western Sector
- Central Sector
- Eastern Himalaya

List Of Recommended Reference Books

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

Practical:
Stratigraphy and Geology of India

I) Study of common sedimentary, igneous and metamorphic rocks in Hand specimen from different stratigraphic horizons.
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) Characteristics of a Fold & Fault from a geological map.
   c) Stratigraphic Boundary Problem.
   d) Understanding Precambrian Geological Time Scale.

T.Y. B.Sc. Geology **Course: S.Geo.5.02**
Title: Igneous Petrology

Learning objective:
To provide students a systematic approach in understanding the origin of igneous rocks, nomenclature, classification and their association with particular tectonic settings.

Number of lectures: 60

Unit-1 **(15 lectures)**
The Interior of the Earth:
Evidence of the Earth's Composition and Mineralogy: Seismic data, The Geothermal Gradient, Meteorites, Xenoliths.
Mantle Petrology; Low Velocity Zone, Pressure and Temperature variations with Depth and high pressure experimentation.
Classification and Description of Igneous Rocks:
The IUGS Classification System, Other aspects of classification; Chemical Classification;
Textures of Igneous rocks,
Crystallinity, Granularity, Shape of Crystals and Mutual Relations.
Equigranular, Inequigranular, Directive and Intergrowth Textures.
Terms related to some specific Textures and Microstructures :Perlitic Cracks, Spherulites, Orbicular Structure, Rapakivi Structure, Zoned Crystals, Xenocrysts, Quench Texture, Crystal Pseudomorph, and Cumulus Crystals.
Characters of the Common Igneous Rocks: Plutonic and Volcanic types; Examples of Common Igneous Rock Types and their Indian Occurrences.

Unit 2 **(15 lectures)**
The Phase Rule and crystallization and melting relations in one, two and three component Systems:
Melting Behavior of Natural Magmas, Phase Equilibrium and The Phase Rule, One Component Systems, Two Component (Binary Systems) and Its Petrogenetic Significance. Binary Systems with Complete Solid Solution, Binary Eutectic Systems, Binary Peritectic Systems, the Alkali Feldspar System,
Ternary Systems:- Ternary Eutectic Systems, Ternary Systems with Solid Solution Reaction Series, The Effect of Pressure and Fluid on Melting Behavior. The effects of Pressure on the Melting and Crystallization of Magma; Time and Crystallization; Rock Types and Mode of Occurrence.

Unit 3 **(15 lectures)**
The Evolution of Magmas:
Differentiation: Fractional Crystallization; Other Differentiation Mechanisms.
Magmatic Mixing and Assimilation.
Melting of the Mantle, Partial Melting, Magma Generation and Differentiation.
Generation of Basaltic magma from a Chemically Uniform Mantle.

Unit 4 **(15 lectures)**
Brief study of Plate tectonic settings and associated igneous rocks.

Subduction –Related Activity: Island Arc Volcanism, Rocks and Magma Series, The Ophiolite Suite; Calcalkaline and Tholeiite Groups; Petrogenesis of Island Arc Magmas, Plutonic Rocks – Batholiths related to subduction zones.
Gabbroic Layered Intrusions; Anorthosites; Alkali Basalts and Nephelinites; Carbonatites, Kimberlites and related Rocks.

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.
10. Philpotts A. R. (2009), Petrography of Igneous and Metamorphic Rocks, Cambridge University Press, 686p.

Practical Course:

Megascopic identification and Petrography of Igneous Rocks

Igneous Textures.

Equigranular:

a. Coarse –grained, Holocrystalline, Panidomorphic.
b. Coarse –grained, Holocrystalline, Hypidiomorphic
c. Medium –grained, Holocrystalline, Hypidiomorphic
d. Fine –grained, Holocrystalline, Panidomorphic. (Orthophyric)
e. Fine –grained, Holo/ Hemicrystalline, Hypidiomorphic
f. Fine-grained, Holocrystalline, Allotriomorphic (Aplitic)
g. Fine- grained, Hemicrystalline, Aphanitic, (Felsitic)
h. Fine –grained, Holohyaline, Aphanitic

Inequigranular:

a. Coarse/Medium/Fine, Holo/Hemicrystalline, Porphyritic
b. Coarse/Medium/Fine, Holo/Hemicrystalline, Glomeroporphyritic
c. Coarse/Medium, Holo/Hemicrystalline, Ophitic/ Subophitic
d. Medium/ Fine, Holo/Hemicrystalline, Poikilitic
e. Medium/Fine, Holocrystalline, Intergranular
f. Medium/Fine, Hemicrystalline, Intersertal
g. Medium/Fine, Intergranular-cum-ophitic (Ophimottling)

Directive:

a. Fine, Hemicrystalline/Holohyaline, Banded (Fluidal)
b. Fine, Hemicrystalline, Trachytic

Intergrowth:

a. Graphic/Micrographic
b. Perthitic

c. Granophyric

Igneous Mega-Structures

1. Vesicular/ Amygdaloidal Lava
2. Blockery/ Clinkery Lava
3. Ropy Lava Surface
4. Columnar Joint Block
5. Flow Banding
6. GlomeroporphyriticClustures
7. Intrusive Contacts and Xenoliths

Igneous Micro-Structures

1. Reaction: (a. Corona , b. Myrmekite)
2. Xenolithic
3. Spherulitic/ Variolitic
4. Perlitic Fracture

Study of the Texture, Mineral composition, Mode of occurrence, and Association of the following Rock Types.

1. Granite
2. Rhyolite
3. Pegmatite
4. Aplite
5. Quartz porphyry
6. Pitchstone
7. Obsidian
8. Syenite (Hornblende / Biotite)
9. Trachyte
10. Feldspar porphyry
11. NephelineSyenite
12. Diorite
13. Gabbro
14. Norite
15. Dolerite
16. Basalt (Vesicular/ Non- Vesicular/ Porphyritic, Amygdaloidal)
17. Picrite
18. Peridotite
19. Dunite
20. Anorthosite
21. Carbonatite

T.Y.B.Sc Geology **Course: S.Geo.5.03**

Title: Structural Geology

Learning Objectives:

To understand the concept of stress and strain and how rock behaves under different stress regimes. A detailed study of various geological structures i.e. Joints, Folds and Faults

Number of lectures: 60

Unit 1 **(15 lectures)**

Introduction, Types of Structures, Stress, Strain, Measurements of Stress and Strain, Mechanical Behaviour of Rocks

Introduction and Review
- Structures and Structural Geology
- Fundamental Concepts

Stress
- Definitions
- Stress on a Plane
- Stress at a Point
- Mohr Construction
- Mohr's Hypothesis
- Stress Ellipsoid

Strain
- Definitions
- Kinds of Strain
- Strain Ellipsoid
- Mohr Circles for Strain
- Simple and Pure Shear

Measurement of Strain in Rocks
- Kinds of Strain
- Strain Markers
- Flinn Diagram

Mechanical Behavior of Rock Materials
- Elastic (Hooken) Behavior
- Permanent Deformation – Ductility
- Controlling Factors

Unit 2 **(15 lectures)**

Study of Structures I: Joints and Faults

Joints and Shear Fractures
- Griffith and Coulomb theory of fractures
- Joints and Fracture Mechanics
- Classification of joints

Fault Classification and Terminology
- Anatomy of Faults
- Criteria for Faulting

Fault Mechanics
- Anderson's Fault Types
- Brittle versus Ductile Faults
- Shear Zones
- Shear – Sense Indicators

Thrust Faults

Nature of Thrust Faults
Detachment within a Sedimentary Sequence
Small – Scale Features of Thrust Sheets
Strike – Slip Faults
Properties and Geometry
Environments of Strike – Slip Faulting
Fault Geometry and Other Fault Types
Termination of Strike – Slip Faults
Transforms
Normal Faults
Properties and Geometry

Unit 3 **(15 lectures)**

Study of Structures II: Folds-I

Fold Geometry and Classifications
Descriptive Anatomy of Simple Folds
Map – Scale Parallel Folds and Similar Folds
Recognition of Folds
Fold Classifications
Based on interlimb angle
Ramsay standard classification
Noncylindrical and Sheath Folds
Fundamentals of Parallel Folds and Similar Folds
Complex Folds
Identification of overturned folds
Occurrence and Recognition
Fold Interference Patterns
Recognition of Multiple Fold Phases

Unit 4. **(15 lectures)**

Study of Structures II: Folds-II

Fold Mechanics
Fold Mechanisms and Accompanying Phenomena
Deformation Mechanisms and Strain
Theory of progressive evolution of fold shapes in single competent layers.
Layer parallel shortening
Dependence of fold shape on viscosity contrast in a single layer buckles
High competence contrast, Low Competence contrast
Zone of contact strain and its interrelationship with buckle folds
Change of fold shape with packing distance of competent layers
Fold styles in multilayers

List Of Recommended Reference Books

1. Fossen, H. (2010), Structural Geology, Cambridge University Press
2. Hobbs D.W., Means W.D. And Williams P.F. (1976), An Outline of Structural Geology, John Wiley.
3. Benninson, G and Moseley, K. (2003), An introduction to geological structures and maps, 7th edition, Arnold Publications
4. Lisley, R (2003) Geological structures and maps: a practical guide, Butterworth-Heinemann Ltd.

5. Billings M.P. (1972), Structural Geology, 3rd ed., Prentice- Hall, Inc., Englewood cliffs, New Jersey.
6. Ragan D.M. (1968), Structural Geology- An Introduction to Geometrical Techniques, 2nd ed., John Wiley and Sons.
7. Ramsay J.G. and Huber M.I. (2002), The Techniques of modern structural geology, 2nd ed., Vol. 2, Elsevier Science Ltd.

Practical Course:

- Profiles and cross sections of geological maps with showing various structural features: folds, faults, dykes, two series of dipping beds. (8 mapsatleast)
- Patterns of dipping strata; Three-Point problems.
- Trigonometric solution of fault problems
- Equal-area net part I

a. Plotting a line that lies in a plane
b. Determining the angle between two lines
c. True strike and Dip from apparent dips
d. Attitude of intersection of two planes

- Equal-area net part II

a. Determining the angle between two planes
b. Determining the orthographic projection of a line on a plane
c. Determining the angle between a line and a plane
d. Bisecting the angle between two lines
e. Bisecting the angle between two planes

T.Y. B.Sc. Geology **Course: S.Geo.5.04**
Title: Metamorphic Petrology.

Learning Objectives:
As a branch of petrology, metamorphic petrology deals with the change in rock structure, composition and texture based on the varying pressure and temperature conditions. This course aims at preparing the learner for appreciating the processes that lead to such changes. The learner will be able to identify in hand specimen as well as through petrographic examination, the various rocks.

Number of lectures: 60

Unit 1: (15 lectures)
Introduction to Metamorphic Petrology
Definition of metamorphism.
Agents of metamorphism
Types of Metamorphism
Introduction to metamorphic fluids
Metasomatism and examples of metasomatism
Classification of Metamorphic rocks
Textures and structures of metamorphic rocks

Unit 2: (15 lectures)
Thermodynamics and metamorphism
Phase rule and phase diagrams
Introduction to chemographic projections
Types of metamorphic reactions
Concept of metamorphic facies

Unit 3: (15 lectures)
Metamorphism- types and products-I
Metamorphism of basic rocks and theirfacies
UHP and UHT metamorphism of basic rocks
Introduction to P-T-t paths
Metamorphism of pelitic rocks- Barrovian zones
Partial melting and migmatites

Unit 4: (15 lectures)
Metamorphism- types and products-II
Metamorphism of carbonate rocks- Contact and regional
Zones of metamorphism of calc-silicate rocks
Charnockites and Khondalites-Granulites with reference to Indian examples
Porphyroblasts and Tectonism: pre-, syn- and post- tectonic porphyroblasts
Introduction to paired metamorphic belts

List Of Recommended Books:

1. Winter J.D (2013) Principles of Igneous and Metamorphic Petrology (Second Edition), PHI Learning Private Limited, Delhi.
2. Williams H, Turner F.J & Gilbert C.M. (1955), Petrography, W.H. Freeman and company. San Francisco, 406p.
3. Greensmith J. (1989), Petrology of the Sedimentary rocks (7th Edition), C.B.C. Publishers, New Delhi.
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. Yardley Bruce W.D. (1989), An Introduction to Metamorphic Petrology, Longman Singapore Publishers (Pvt.) Ltd.
6. Harker Alfred (1974), Metamorphism, Chapman and Hall, London.
7. Turner F.J and Verhoogen J. (1960), Igneous and Metamorphic Petrology, McGraw-Hill.
8. Bayley B. (1996), Introduction to Petrology, Prentice Hall, New York.
9. Miyashiro A. (1998), Metamorphism and Metamorphic Belts, George Allen &Unwin, New York.
10. Mason Roger (1984), Petrology of the Metamorphic Rocks, CBS Publishers and Distributors, New Delhi.
11. Winkler Helmut G.F. (1987), Petrogenesis of Metamorphic Rocks (Fifth Edition), Narosa Publishing House, New Delhi.
12. Philpotts A and Ague J. (2009) Principles of Igneous and Metamorphic Petrology (Second Edition), Cambridge University Press, UK.

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Practical Course:

Calculations of stable mineral composition at equilibrium

Megascopic and Microscopic Identification of Metamorphic Rocks.

Metamorphic Textures

1.Idioblastic
2. Porphyroblastic
3. Granuloblastic
4. Xenoblastic

Metamorphic Structures

1.Cataclastic
2. Slaty cleavage
3.Maculose
4. Granulose
5. Schistose
6. Gneissose

Metamorphic Rocks

1. Quartzite
2. Marble
3. Slate
4. Phyllite
5. Mica Schist (with Staurolite/ Garnet)
6.Actinolite/ Chlorite Schist

7.Mica- Gneiss
8. Hornblende Gneiss.
9. Granulite
10. Eclogite
11. Serpentinite
12. Khondolite
13. Charnockite

S.Geo. 5.01, 5.02, 5.03, 5.04 courses

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

CIA- 40 marks

CIA 1: Written test -20 marks

CIA 2: Assignment -20 marks (Pre field report: This will be for all the four courses, that is 20 marks each,)

End Semester Examination – 60 marks

One question from each unit for 15 marks, with internal choice. Total marks per question with choice -20 to 22.

Evaluation of S.Geo.5.PR (Practicals) Total marks per Practical course - 200.

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Template for S.Geo courses End Semester examination in Semester 5

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%**

Template for Evaluation of course S.Geo.5.0 CIA 2

St. Xavier's College, Mumbai **Course: S.GEO.5.01/5.02/5.03/5.04**

Department of Geology **Roll Number: _____**

UID Number:_____

MARKS:____/20

Evaluation Grid for Course: S.GEO.5.01/5.02/5.03/5.04 - CIA 2 - Assignment

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**

T.Y. B.Sc. Geology **Course: S.Geo.5.AC**
Title: Remote Sensing and Image Interpretation

PRE-REQUESITES: Courses S.Geo.3.0 and S.Geo.4.0
Additional Requirements (Recommended): Laptop Computer.

Learning Objectives:
Gathering data about various earth surface features through space and air borne sensors has been effectively used for understanding and analyzing various phenomenon ranging from vegetation , agriculture, natural resources mapping and exploitation to environment monitoring. Remote sensing is today an integral part of any study that needs inputs in the form of spatial and spectral reflectance of earth's surface characteristics. This course, aimed at all learners with a background in the earth sciences, will develop skills in understanding how the satellite image date is acquired and interpreted. The use of printed satellite imageries as well as data in digital form will result in the learner also developing the necessary competence in automated classification of satellite image data.

Number of lectures: 60

Unit 1 **(15 lectures)**
Concepts of Remote Sensing
Concepts and Foundations of Remote Sensing
Definition of Remote Sensing.
Energy Sources and Radiation Principles.
Energy interactions in the Atmosphere: Scattering, Absorption.
Energy interactions with earth surface features: Spectral Reflectance of Vegetation, Soil and Water, Spectral response patterns, Atmospheric Influences on Spectral Response Patterns.
Brief history of Remote Sensing from the advent of photography till today's aerial and space-based remote sensing systems.
The concept of resolution: Spatial, Spectral, Temporal and Radiometric.

Unit 2 **(15 lectures)**
Satellite Sensors and Data
Space Borne Imaging Systems- The Landsat, IRS, SPOT and High resolution Land Satellites (the characteristics of these satellites- their orbits, their sensors, and their resolutions)
Multispectral, Thermal and Hyper spectral Sensing
Across track scanning.
Along track scanning.
Operating principles of Across track Multispectral Scanners.
Across track Thermal scanning.
Thermal Radiation principles.

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.
Classification Accuracy Assessment.

List Of Recommended Reference Books

1. Drury S.A., (1993), Image Interpretation in Geology, 2nd ed., Chapman and Hall, London.
2. Jensen John R. (2000), Remote Sensing of the Environment – An Earth Resource perspective, Pearson Education Series, Low Price Edition.
3. Lillesand T. M., Ralph W. Kiefer and Jonathan W. Chapman (2004), Remote Sensing and Image Interpretation, 5thed, Wiley.
4. Mather Paul M., (2004), Computer Processing of Remotely Sensed Images- An Introduction, 3rd ed., John Wiley.
5. Narayan L.R.A. (1999), Remote Sensing and its Applications., Universities Press.
6. Ramasamy S.M., (2005), Remote Sensing in Geomorphology, New India Publishing Agency.
7. Schowengerdt Robert A., (2006), Remote Sensing – Models and Methods for Image Processing, 2nd ed., Elsevier (Academic Press).
8. Wanless Harold R. (1969), Aerial Stereo Photographs, Hubbard Press, USA.

Practical Course:

Remote Sensing and Image Processing

- Interpretation of Satellite Imagery for – landforms, geological structures, rock and soil types, man made structures.
- Data Products and Meta data
- Digital Image Processing (using number matrix): enhancement, manipulation and classification.
- Digital image processing on Computer
  - Display of various types of image formats
  - Pallets and Display elements
  - Georeferencing
  - Image enhancement
  - Image classification

Evaluation: Applied Component – Remote Sensing and Image Interpretation (Theory) Total marks 100.

CIA- 40 marks

CIA 1: Written test -20 marks

CIA 2: Assignment /MCQ/Test / pre field report -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 22.

Practicals Exam: Total 50 marks.

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Template for S.Geo.5.AC courses - End Semester examination

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%**

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St. Xavier's College
Mumbai

Syllabus
forB.ScVIth Semester Courses in Geology
(November 2017 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 thePhanerozoic stratigraphyof 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 - Spiti 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.
Geology of Mumbai and Suburbs

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

V) Study of characteristicindex fossils of a particular stratigraphic horizon.
VI) Diagrammatic examples of Lithostratigraphic boundaries and classification.
VII) Study of Geological maps with geological history of the area in chronological order.
VIII) Problems:
   e) Stratigraphic sequence from geological section.
   f) Interpretation of depositional environments for stratigraphic sequences.
   g) Stratigraphic Boundary Problem.
   h) 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 formationand 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
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 (3rdEdition), 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

8. Narayanswami S.B.S. (2000), Engineering Geology, DhanpatRai& Co, India.
9. Legget F. R and Hatheway A.W. (1988), Geology and Engineering., 3rd ed. McGraw-Hill.
10. Gupte R.B.(1992), A Textbook of Engineering Geology.2nd ed. Pune VidyarthiGrihaPrakashan.
11. Krynine D.P. And Judd W.R (2003), Principles of Engineering Geology and Geotechniques, CBS Publishers.
12. Wahlstrom E.E. (1974), Dams, Dam Foundations and Reservoir Sites. Elsevier Scientific.
13. Dunn I.S., Anderson L.R and Kiefer F.W. (1980), Fundamentals of Geotechnical Analysis, John Wiley.
14. Maslov N.N. (1987), Basic Engineering Geology and Soil Mechanics. Mir Publishers.
15. 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.
- 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 Elementsof 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 CellData 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 SenguptaSmita(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.

Evaluation and Assessment :S.Geo. 6.01, 6.02, 6.03, 6.04 courses

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

CIA- 40 marks

CIA 1: Written test -20 marks

CIA 2: Field work (12 days, and Field report, Viva on Fieldwork, This will be for all the four courses, that is 20 marks outside Mumbai City)

End Semester Examination – 60 marks

One question from each Unit for 15 marks, with internal choice. Total marks per question with choice -21 to 22 marks.

Evaluation of S.Geo.6.PR (Practicals)Total marks - 200.

*For the purpose of workload – fieldwork is to be considered as 4 hours per week per batch.

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Template for S.Geo courses End Semester examination in Semester 6

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 -Autonomous, Mumbai

Department of Geology

Roll Number: _____

UID Number:_____

MARKS:____/20

Assessment Grid for S.Geo.6.PR CIA 2 (Field Work)

Parameters		Marks	80 – 100% Excellent	60 -80% Good	40 – 60% Satisfactory	20 -40% Poor	0 – 20% Very Poor
Field Trip	Attendance, Field Discipline, Daily field Diary and work completion.	50					
Field Report and Viva		30					
Total		80					

Evaluators Names Signature and date

Name **Signature &date**

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, chemicalvapour 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 PetrKorbel 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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Evaluation: Applied Component –GEMMOLOGY
(Theory) Total marks 100.
CIA- 40 marks

CIA 1: Written test -20 marks
CIA 2: Assignment /MCQ -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 22.

(Practicals) Total 50 marks.
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Template for S.Geo.AC course End Semester examination in Semester 6

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATIONS 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%**

****