# UNIVERSITY OF MUMBAI

No. UG/205 of 2010

T.Y.B.Sc. Geology

CIRCULAR :-

A reference is invited to the Ordinances, Regulations and syllabubs relating to the B.Sc. degree course **vide** this office Circular No.UG/373 of 2008 dated 13th August, 2008 and the Principals of the affiliated Colleges in Science are hereby informed that the recommendation made by the Board of Studies in Geology at its meeting held on 5th April, 2010 has been accepted by the Academic Council at its meeting held on 10th June, 2010 **vide** item No.4.27 and that, in accordance therewith, the syllabus for the T.Y.B.Sc. in the subject of Geology is revised as per **Appendix** and that the same has been brought into force with effect from the academic year 2010-2011.

MUMBAI-400 032
21st July, 2010

L. R. Mane
Offg. Registrar

To,

The Principals of the affiliated Colleges in Science.

A.C./4.27/10/06/2010

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No. UG/205-A of 2010, MUMBAI-400 032 21st July, 2010

Copy forwarded with compliments for information to:-

1) The Dean, Faculty of Science,
2) The Chairman, Board of Studies in Geology,
3) The Controller of Examinations,
4) The Co-Ordinator, University Computerization Centre,

(D. N. Jadhav)
Ag. Deputy Registrar
(UG/PG Section)

Copy to :-

The Director, Board of College and University Development, the Deputy Registrar (Eligibility and Migration Section), the Director of Students Welfare, the Executive Secretary to the to the Vice-Chancellor, the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative sub-center, Ratnagiri for information.

The Controller of Examinations (10 copies), the Finance and Accounts Officer (2 copies), Record Section (5 copies), Publications Section (5 copies), the Deputy Registrar, Enrolment, Eligibility and Migration Section (3 copies), the Deputy Registrar, Statistical Unit (2 copies), the Deputy Registrar (Accounts Section), Vidyanagari (2 copies), the Deputy Registrar, Affiliation Section (2 copies), the Professor-cum- Director, Institute of Distance Education, (10 copies) the Director University Computer Center (IDE Building), Vidyanagari, (2 copies) the Deputy Registrar (Special Cell), the Deputy Registrar, (PRO) the Assistant Registrar, Academic Authorities Unit (2 copies) and the Assistant Registrar, Executive Authorities Unit ( 2 copies). They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action

Enclosure to Item No. 4.27

10.06.2010

# UNIVERSITY OF MUMBAI

## Revised Syllabus

## for the

## T.Y.B.Sc.

## in

## Geology

***(with effect from the academic year 2010 - 2011)***

# T.Y. B.Sc. Geology
# Revised Syllabus w.e.f.2010-11.

**Paper I: Theory Syllabus**
**Title: Stratigraphy and Geology of India, Maharashtra and Mumbai**
**Max. Marks 100.**
**Number of lectures : 120 (4 lectures per week, 2 semesters of 15 weeks each)**

## UNIT 1

**(30 lectures)**

**Introduction: 4 lectures**
Brief Historical Review
Geological Investigations in India

**Earth's Crustal Structure and Tectonic Divisions of India: 6 lectures**
Tectonic Elements of Continents
*Cratons*
*Folded Mountain Belts*
Tectonic Elements of Oceans
Tectonic Divisions of India
*Peninsular India*
*Extra- Peninsular India*
*Indo-Gangetic Plain*

**Precambrian Basement of Indian Peninsula: 20 lectures**
Precambrian history of the Earth
Precambrian basement
*Dharwar Province*
*Eastern Ghats Province*
*Central Indian Province*
*Singhbhum-Orissa Province*
*Aravalli-Bundelkhand Province*

## UNIT 2

**(30 lectures)**

**Proterozoic Formations of Indian Peninsula: 15 lectures**
Proterozoic History
Basement Cover Transition
Proterozoic Succession
Lower Purana Succession
*Delhi Supergroup*
*Bijawar and Gwalior Groups*
*Kolhan Group*
*Cuddapah Supergroup*
*Kaladgi and Pakhal Groups*
Upper Purana Succession
*Vindhyan Supergroup*
*Kurnool Group*
*Northern Extension of Kurnool Group*

**Precambrians of Extra-Peninsula: 15 lectures**

Precambrians of the Tethyan Basement
- *Salkhala Group*
- *Vaikrita Group*
- *Bhimphedi Group*
- *Jutogh Group*
- *Daling Group*

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

**UNIT 3** **(30 Lectures)**

**Palaeozoic History: 15 lectures**

Tectonic History
Palaeozoic Life
Precambrian Cambrian Boundary
Marine Palaeozoic Formations of India
- *Tethyan Regions*
- *Lesser Himalayan Regions*

**Mesozoic History: 15 lectures**

Tectonic History
History of Mesozoic Life
- *Marine Forms*
- *Land Forms*

Permian-Triassic Boundary
Marine Mesozoic Formations of India
- *Tethyan Himalaya*
- *Lesser Himalaya (Krol Belt)*
- *Indian Peninsula*

**UNIT 4** **(30 Lectures)**

**Gondwana Sequence of India: 10 lectures**

Sedimentation and Palaoclimates
Lower Gondwana Sequence
- *Talchir Formation*
- *Marine Intercalations*
- *Bap and Badhaura Formations*
- *Damuda Group*
- *Lower Gondwana of Eastern Himalayas*

Upper Gondwana Sequence
- *Damodar Valley Basin*
- *Satpura Basin*
- *Rajmahal Hills*
- *Mahanadi-Son valley Basin*
- *Pranhita-Godavari Basin*

**Cenozoic History: 10 lectures**

Tectonic History

*Rise of the Tertiary Mountains*

History of Cenozoic Life

Boundary Problems

Indian Cenozoic Formations

*Himalayan Palaeogene Succession*

*Himalayan Neogene Succession*

*Indus Belt*

*Deccan Traps*

*Assam-Arakan Region*

*Andaman-Nicobar Islands*

*Northwestern Peninsula*

*Cauveri and Godavari Basins*

**Geology of Maharashtra and Mumbai: 10 lectures**

Geology of the State

Geological distribution of minerals

**References**

Prasad, C.V.R.K (2005), Elementary Exercises in Geology; Universities Press (India) Pvt. Ltd., Hyderabad.

Directorate of Geology and Mining, Nagpur – Geology and Mineral Resources Of Maharastra – 2000.

G. G. Despande (1998), Geology of Maharastra; Geological Society of India, Bangalore.

Ravindra Kumar (1996), Fundamentals 0f Historical Geology and Stratigraphy of India; 4th ed., New Age International Limited.

Cesare Emiliani (1995), Planet Earth- Cosmology, geology and the evolution of life and environment; Low Price Ed. Cambridge University Press, U. K.

Roy, R. Lemon (1990), Principles of Stratigraphy; Merrill Publishing Company, Ohio.

Harold L. Levin (1987), The Earth Through Time; 3rd Ed. Saunders College Publishing, New York.

D. N. Wadia (1984), Geology of India; 4th Ed. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

M. S. Krishnan (1982), Geology of India and Burma; 6th Ed. CBS Publishers & Distributors (India)

**T.Y. B.Sc. Geology**
**Paper II: Theory Syllabus**
**Title: Igneous, Sedimentary and Metamorphic Petrology**
**Max. Marks 100.**
**Number of lectures : 120 (4 lectures per week, 2 semesters of 15 weeks each)**

**(30 lectures)**

**UNIT 1**

**Igneous Petrology**

**Experiments with Molten Silicates**: Unary and Binary Systems
Phase Relations and Textures – One Component System and the Phase Rule; Two Component Systems: – Congruent Melting, Incongruent Melting and Solid Solution relationships; Textures and Structures (Mega & Micro) of Igneous Rocks.
Ternary Systems :- Simple and Complex
The effects of Pressure on the Melting and Crystallization of Magma; Time and Crystallization; Rock Types and Mode of Occurrence.

**Classification and Description of Igneous Rocks:**
The IUGS Classification System, Other aspects of classification;
Chemical Classification;
Characters of the Common Igneous Rocks: Plutonic and Volcanic types; Examples of Common Igneous Rock Types.

**The Evolution of Magmas:**
Differentiation: Fractional Crystallization; Other Differentiation Mechanisms.
Magmatic Mixing and Assimilation.

**(30 lectures)**

**UNIT 2**

**The Interior of the Earth:**
Evidence of the Earth's Composition and Mineralogy: Seismic data, The Geothermal Gradient, Meteorites, Xenocrysts, High-Pressure Experimentation.
Mantle Petrology; Low Velocity Zone.

**The Formation of Magmas at Rift Zones:**
Melting Processes; Partial Melting; Observations at the Mid-Ocean-Ridges.

**Igneous Rocks at the Continental Margins:**
The Ophiolite Suite; Calcalkaline and Tholeiite Groups; Plutonic Rocks – Batholiths related to subduction zones.

**Continental Igneous Rocks:**
Gabbroic Layered Intrusions; Anorthosites; Alkai Basalts and Nephelinites; Carbonatites, Kimberlites and Related Rocks.

UNIT 3

## Sedimentary Petrology

(30 lectures)

**The Occurrence of Sedimentary Rocks:**
Types of Sedimentary Rocks- Mudrocks, Sandstones and Carbonate Rocks
Depositional Basins, Geosynclines and Plate Tectonics; Ocean Basins- Rifted Continental Margins, Arc-Trench Systems, Suture Belts and Intracontinental Basins.

**The Formation of Sediment:**
Chemical Weathering: Granite; The effect of vegetation; Basalt; Submarine Alteration.
Clay Minerals; Clay Mineralogy and Climate; Laterite.
Mechanical Weathering.

**Sedimentary Texture:**
Grain Size, Grain Size Measurement, Roundness and Shape, Grain to Grain relationship.

**Mudrocks:**
Field Observations: Textures, Structures, Colour, Nomenclature
Laboratory Studies: Mineral composition; Bentonites; Mudrocks and Source areas.

**Sandstones and Conglomerates:**
Field Observations: Textures, Colour, Distance from source, Structures, Mineral composition.
Laboratory Studies: Textures, Mineral coposition; Recycling of Grains.
Classification of Sandstones and conglomerates.

**The Diagenesis of Sandstones:**
Compaction – Field Observations; Laboratory Studies.
Cementation: Pore-Filling Cements, Intrastratal solution.

**Limestones and Dolomites:**
Field Observations of Limestones: Textures; Noncarbonate Mineralogy; Classification; Structures; Reefs and Palaeoclimate; Diagenesis.
Laboratory Studies: Allochemical and Orthochemical Particles.
Sites of Calcium Carbonate Deposition; Modern Reef Environments.
Dolomites: Laboratory Studies; Modern Dolomite. Dolomitization and dedolomitization.

**Other Types of Sedimentary Rocks:**
**Evaporites,** Origin of Giant Evaporite Deposits; Evaporites and Climate.
**Bedded Cherts**: Phanerozoic Marine Cherts; Phanerozoic Nonmarine Cherts; Precambrian Cherts.
**Bedded Phosphate Rocks**: Origin of Phosphorites; The Phosphorite Formation.
**Bedded Iron Deposits**: Oolitic Iron Formations; Bedded Iron Formations.

**UNIT 4** **(30 lectures)**

**Metamorphic Petrology**

**The Occurrence of Metamorphic Rocks:**
Recognition of Metamorphic Rocks; Common Metamorphic Rocks.
Field Observations of Metamorphic Rocks: Regional Metamorphism, Contact Metamorphism, Other Types of Metamorphism; Isograds.

**Facies and Graphic Representation:**
The Facies Concept; Equilibrium; The Phase Rule; Graphic Representation.

**Controls and Processes of Metamorphism:**
The Controls: Pressure, Temperature and Composition.
Metamorphic Processes: Initiation of metamorphism, Contact Metamorphism, Metamorphism of Igneous Rocks, Submarine Metamorphism; Porphyroblasts; Preferred Orientation; Metamorphic Differentiation.
Metamorphic Reactions.
The Upper Limits of Metamorphism.

**Mineral Changes During Metamorphism:**
Mineral Variation and Metamorphic Facies: Zeolite and Prehnite-Pumpellyite-Metagraywacke Facies, Greenschist Facies, Epidote-Amphibolite Facies, Amphibolite Facies, Granulite Facies, Blueschist Facies, Eclogite Facies, Hornfels and Sanidinite Facies.
Mineral Variation Related to Initial Rock Composition: Carbonate rocks, Mudrocks, Maffic Igneous Rocks and Tuffs, Ultrabasic Rocks.

**Time, Temperature and Deformational Relationships:**
Porphyroblasts and Tectonism: Pretectonic, Syntectonic and Post-Tectonic Porphyroblasts; More complex situations.
Polymetamorphism.
Determination of Pressure and Temperature: Use of Total Assemblage, Changes in Mineral Composition.

**Metamorphic Rocks and Global Tectonics:**
Metamorphism at Transform Faults and Divergent Junctions; Metamorphism at Convergent Junctions, Time of Formation of Paired Belts.

## Recommended Books:


1. Tyrrel G.W. (1998). The Principles of Petrology. B.I. Publications Pvt. Ltd.
2. Bose M.K. (1997). Igneous Petrology. The World Press Pvt. Ltd.
3. Bowen N.L. (1928). The evolution of Igneous Rocks. Princeton Univ. Press. N.J.
4. Hall A. (1987). Igneous Petrology. Longman.
5. Hatch F.H., Wells A.K and Wells M.K. (1984) Petrology of the igneous rocks. CBS Publishers.
6. Philpotts A.R. (1994). Principles of igneous and metamorphic Petrology, Prentice Hall of India.
7. Turner F.J & Verhoogen J., Igneous and Metamorphic Rocks, Mc Graw- Hill
8. Williams H, Turner F.J & Gilbert C.M. (1955) Petrography. San Francisco: W.H. Freeman and company.
9. Sengupta S.M (1994). Introduction to Sedimentology. Oxford& IBH Publishing Co. Pvt. Ltd.
10. Blatt H, Middleton G. & Murray R. (1972). Origin of Sedimentary rocks. Prentice-Hall, Englewood Cliff, N.J.
11. Pettijohn F.J (1962) Sedimentary Rocks.
12. Tucker E.M introducition to sedimentary petrology
13. Yardley. INTRODUCTION TO METAMORPHIC PETROLOGY
14. Bhaskar B. Rao..(1987), Metamorphic Petrology.

**T.Y. B.Sc. Geology**
**Paper III: Theory Syllabus:**
**Title: Structural Geology and Engineering Geology.**
**Max. Marks 100.**
**Number of lectures : 120 (4 lectures per week, 2 semesters of 15 weeks each)**

UNIT 1 **(30 lectures)**

**Structural Geology**

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

Introduction and Review

A. Structures and Structural Geology
B. Fundamental Concepts
C. Plate Tectonics

Nontectonic Structures

1. Primary Sedimentary Structures
2. Sedimentary Facies
3. Dewatering Structures
4. Unconformities

Stress

1. Definitions
2. Stress on a Plane
3. Stress at a Point
4. Mohr Construction
5. Mohr's Hypothesis
6. Stress Ellipsoid

Strain

A. Definitions
B. Kinds of Strain
C. Strain Ellipsoid
D. Mohr Circles for Strain
E. Simple and Pure Shear

Measurement of Strain in Rocks

- Kinds of Strain
- Strain Markers
- Flinn Diagram

Mechanical Behavior of Rock Materials

a. Elastic (Hooken) Behavior
b. Permanent Deformation – Ductility
c. Controlling Factors

UNIT 2

**Study of Structures: Joints, Faults.** **(30 lectures)**

Joints and Shear Fractures

1. Joints and Fracture Mechanics
2. Joint in Plutons

Fault Classification and Terminology

1. Anatomy of Faults
2. Andersonian Classification
3. Criteria for Faulting

Fault Mechanics

a. Anderson's Fault Types
b. Brittle versus Ductile Faults
c. Shear Zones
d. Shear – Sense Indicators

Thrust Faults

I. Nature of Thrust Faults
II. Detachment within a Sedimentary Sequence
III. Small – Scale Features of Thrust Sheets

Strike – Slip Faults

15. Properties and Geometry
16. Environments of Strike – Slip Faulting
17. Fault Geometry and Other Fault Types
18. Termination of Strike – Slip Faults
19. Transforms

Normal Faults

1. Properties and Geometry

**UNIT 3**

**Study of structures:Folds, Cleavage and Foliation, Linear structures.** **(30 Lectures)**

Fold Geometry and Classifications

1. Descriptive Anatomy of Simple Folds
2. Map – Scale Parallel Folds and Similar Folds
3. Fold Classifications

Mechanics of Folding

1. Fold Mechanisms and Accompanying Phenomena
2. Deformation Mechanisms and Strain
3. Noncylindrical and Sheath Folds
4. Fundamentals of Lineations and Fold Mechanics
5. Fundamentals of Parallel Folds and Similar Folds

Complex Folds

a. Occurrence and Recognition
b. Fold Interference Patterns
c. Recognition of Multiple Fold Phases
d. Noncylindrical and Sheath Folds

Cleavage and Foliations

a. Cleavage – Bedding Relationships
b. Cleavage Refraction
c. Strain and Slaty Cleavage
d. Crenulation Cleavage
e. Cleavage Fans and Transecting Cleavages

Linear structures

- Lineations as Shear – Sense Indicators
- Folds and Lineations
- Deformed Lineations

**UNIT 4** **(30 lectures)**

**1.The Engineering Properties of Rocks:(8 lectures)**

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

**2. Rocks as Construction Materials: ( 7 lectures)**

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

V. **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.

**3. Geological and Geotechnical investigations for Civil Engineering Projects:(15 lectures)**

a) **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.

b) **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.

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

## Reference Books:

### Structural Geology


1. Hatcher,Jr R.D., (1990), Structural Geology, Merrill Publishing Company.
2. Ghosh S.K., (1993), Structural Geology, Pergamon Press.
3. Pradeep Raj., (1997), Geological Maps, Concepts of Interpretation Practical Record with Key, Creative Educators.
4. Hobbs D.W., Means W.D. And Williams P.F. (1976), An Outline of Structural Geology, John Wiley.
5. Billings M.P.,(1972), Structural Geology, 3rd ed., Prentice- Hall, Inc., Englewood cliffs, New Jersey.
6. De Sitter L.U.,(1956), Structural Geology, McGraw-Hill Book Company, INC.
7. Ragan D.M., (1968) Structural Geology- An Introduction to Geometrical Techniques, 2nd ed., John Wiley and Sons, 166p
8. Badgley P.C., (1959) Structural Methods For the Exploration Geologist, Oxford Book Company.


### Engineering Geology


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

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### Structural Geology


1. Hatcher,Jr R.D., (1990), Structural Geology, Merrill Publishing Company.
2. Ghosh S.K., (1993), Structural Geology, Pergamon Press.
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5. Billings M.P.,(1972), Structural Geology, 3rd ed., Prentice- Hall, Inc., Englewood cliffs, New Jersey.
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7. Ragan D.M., (1968) Structural Geology- An Introduction to Geometrical Techniques, 2nd ed., John Wiley and Sons, 166p
8. Badgley P.C., (1959) Structural Methods For the Exploration Geologist, Oxford Book Company.


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

**T.Y. B.Sc. Geology**
**Paper IV: Theory Syllabus:**
**Title: Remote Sensing and Image Interpretation, Photogrammetry, Geographical Information Systems.**
**Max. Marks 100.**
**Number of lectures : 120 (4 lectures per week, 2 semesters of 15 weeks each)**

## UNIT 1

**Remote Sensing** **( 30 lectures)**

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.
- 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 Hyperspectral Sensing
- Across track scanning.
- Along track Scanning.
- Operating principles of Across track Multispectral Scanners.
- Across track Thermal Scanning.
- Thermal Radiation principles.

## UNIT 2

**Image Interpretation** **(30 lectures)**

- Fundamentals of Visual Image Interpretation.
- Basic Visual Image Interpretation Equipment- Construction and Working.
- Land-use/Land cover mapping.
- Geologic and Soil mapping.
- Agricultural Applications.
- Forestry Applications.
- Water Resource Applications.
- Archaeological Applications.
- Environmental Assessment
- Principles of Landform Identification.
- Interpretation of Thermal Scanner Imagery.
- Geometric Characteristics of Across track scanner Imagery.
- Geometric Characteristics of Along-Track Scanner Imagery.
- Radiometric Calibration of Thermal Scanners.
- Temperature Mapping with Thermal Scanner Data.
- Hyperspectral Sensing.

UNIT 3

**Digital Image Processing** **(30 lectures)**

Introduction.
Image Rectification and Restoration.
Image Enhancement.
Contrast Manipulation.
Spatial Feature Manipulation.
Multi-Image Manipulation.
Image Classification: Supervised Classification.
The Classification Stage: Minimum-Distance to Means Classifier, Parallelepiped Classifier.
Gaussian Maximum Likelihood Classifier.
The Training Stage.
Unsupervised Classification.
Classification Acuracy Assessement.

UNIT 4

**Photogrammetry and GIS** **(30 Lectures)**

Principles of Photogrammetry:
Introduction.
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.
Relief Displacement of Vertical Features: 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, Basics of The collinearity condition, Basics of Space Intersection.
Flight Planning.

**Introduction to Geographical Information Systems**

What is GIS? - 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,

**Reference Books:**

**Remote Sensing and Image Interpretation:**


1. Lillisand Thomas M, Ralph W. Kiefer and Jonathan W. Chapman, (2004), Remote Sensing and Image Interpretation., 5th ed, Wiley.
2. Jensen John R., (2000), Remote Sensing of the Environment – An Earth Resource perspective., Pearson Education Series, Low Price Edition.
3. Drury S.A., (1993), Image Interpretation in Geology., 2nd ed., Chapman and Hall., London.
4. Schowengerdt Robert A., (2006), Remote Sensing – Models and Methods for Image Processing., 2nd ed., Elsevier (Academic Press).
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. Mather Paul M., (2004), Computer Processing of Remotely Sensed Images- An Introduction.,3rd ed., John Wiley.
8. Wanless Harold R. (1969), Aerial Stereo Photographs., Hubbard Press, USA.


**Photogrammetry:**


1. Lillisand Thomas M, Ralph W. Kiefer and Jonathan W. Chapman, (2004), Remote Sensing and Image Interpretation., 5th ed., Wiley.
2. Miller, V. C., (1961), Photogeology, McGraw-Hill.
3. Linder Wilfried (2003), Digital Photogrammetry- Theory and Applications., Springer.
4. Misra R.P. and A. Ramesh, (1999), Fundamentals of Cartography., 2nd ed, Concept Publishing Company. New Delhi.


**Introduction to Geographical Information Systems:**


1. Nag P. and Smita Sengupta., (2008), Introduction to Geographical Information System., Concept Publishing Company, New Delhi.
2. Burrough Peter A. and Rachael A. McDonnell., (1998), Principles of Geographical Information Systems., Oxford University Press.
3. Chang K. (2002), Introduction to Geographical Information Systems., Tata McGraw-Hill Edition.
4. Morain Stan and Shirley Lopez Baros. (ed), (1996), Raster Imagery in Geographical Information Systems., Onward Press.
5. Davis Bruce E. , (1996), GIS – A Visual Approach., Onward Press.


Pattern of Theory Examination

Each theory paper will consist of 5 compulsory questions with internal options. Each question will be of 20 marks. Total marks for each question including internal options will be of maximum 30 marks.

The question paper pattern will be as follows:
Q1. based on entire syllabus
Q2,3,4,5 based on one unit each.

# T.Y. B.Sc – Geology
## Syllabus (Practicals and Fieldwork)

**Max Marks : 200.**
**4 periods per week per paper. Practical exam of minimum 4 hours duration.**
**Marks to be allotted for Field work and field report from each of the four practical papers.**

**FIELD WORK: 10 days of geological field work to carry out geological mapping in an area outside Mumbai city. Local field work 3 days for understanding the local geology of Mumbai and surrounding areas.**

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**Paper 1: Stratigraphy and Geology of India, Maharashtra and Mumbai**

I Study of common sedimentary, igneous & metamorphic rocks in hand specimen from different stratigraphic horizons.

II Study of common fossils characteristics of a particular stratigraphic horizons.

III Diagrammatic examples of Lithostratigraphic boundaries and classification.

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

V Problems:

a) Stratigraphic sequence from geological section.

b) Stratigraphy of a geological section- fossils & radiometric age.

c) Characteristics of a Fold & Fault from a geological map.

d) Boundary Problem.

e) Preparation of Geological Time Scale.

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**Paper 2: Igneous, Sedimentary and Metamorphic Petrology.**

**I. Study of Megascopic and Microscopic textures and structures in Rocks.**

**D. Igneous Textures.**

7. EQUIGRANULAR:

e. Coarse –grained, Holocrystalline, Panidomorphic.
f. Coarse –grained, Holocrystalline, Hypidiomorphic
g. Medium –grained, Holocrystalline, Hypidiomorphic
h. Fine –grained, Holocrystalline, Panidomorphic. (Orthophyric)
i. Fine –grained, Holo/ Hemicrystalline, Hypidiomorphic
j. Fine-grained, Holocrystalline, Allotriomorphic (Aplitic)
k. Fine- grained, Hemicrystalline, Aphanitic, (Felsitic)
l. Fine –grained, Holohyaline, Aphanitic

8. INEQUIGRANULAR:
d. Coarse/Medium/Fine, Holo/Hemicrystalline, Porphyritic
e. Coarse/Medium/Fine, Holo/Hemicrystalline, Glomeroporphyritic
f. Coarse/Medium, Holo/Hemicrystalline, Ophitic/ Subophitic
g. Medium/ Fine, Holo/Hemicrystalline, Poikilitic
h. Medium/Fine, Holocrystalline, Intergranular
i. Medium/Fine, Hemicrystalline, Intersertal
j. Medium/Fine, Intergranular-cum-ophitic (Ophimottling)

9. DIRECTIVE:
a. Fine, Hemicrystalline/Holohyaline, Banded (Fuidal)
b. Fine, Hemicrystalline, Trachytic

10. INTERGROWTH:
e. Graphic/Micrographic
f. Perthitic
g. Granophyric

**E. Igneous Mega-Structures**
6. Vesicular/ Amygdaloidal Lava
7. Blockey/ Clinkery Lava
8. Ropy Lava Surface
9. Columnar Joint Block
10. Flow Banding
11. Glomeroporphyritic Clustures
12. Intrusive Contacts and Xenoliths

**F. Igneous Micro-Structures**
3. Reaction: (a. Corona , b. Myrmekite)
4. Xenolithic
5. Spherulitic/ Variolitic
6. Perlitic Fracture

**G. Sedimentary Textures.**
f. Clastic.
g. Rudaceous (Conglomeratic/ Brecciatic)
h. Arenaceous (Gritty/ Sandy)
i. Argillaceous.

**H. Sedimentary Structues**
1. Stratification
2. Current Bedding
3. Graded Bedding
4. Ripple Marks
5. Rain Prints
6. Concretions/Secretions

I. **Metamophic Textures**

4. Idioblastic
5. Porphyroblastic
6. Granuloblastic
7. Xenoblastic

J. **Metamorphic Structures**

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

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

**F. Igneous Rocks.**

4. Granite
5. Rhyolite
6. Pegmatite
7. Aplite
8. Quartz porphyry
9. Pitchstone
10. Obsidian
11. Syenite (Hornblende / Biotite)
12. Trachyte
13. Feldspar porphyry
14. Nepheline Syenite
15. Diorite
16. Gabbro
17. Norite
18. Dolerite
19. Basalt (Vesicular/ Non- Vesicular/ Porphyritic)
20. Picrite
21. Peridotite
22. Dunite
23. Anorthosite
24. Carbonatite
25. Volcanic Breccia

## G. Sedimentary Rocks

1. Conglomerate
2. Breccia
3. Grit
4. Sandstone
5. Slate
6. Limestone
7. Fossiliferous Limestone
8. Oolitic Limestone
9. Laterite

## H. Metamorphic Rocks

5. Quartzite
6. Marble
7. Chiastolite- Slate
8. Phyllite
9. Mica Schist (with Staurolite/ Garnet)
10. Actinolite/ Chlorite Schist
11. Mica- Gneiss
12. Hornblende Gneiss.
13. Granulite
14. Eclogite
15. Serpentinite
16. Khondolite
17. Charnockite

**Paper 3: Structural Geology and Engineering Geology.**

**Structural Geology:**

a. Profiles and cross sections across geological maps with: folds, plunging folds, dipping faults, dipping dykes, two series of dipping beds, overturned folds. (10 maps)
b. Patterns of Dipping strata; Three-Point problems.
c. Thickness and depth of strata
d. Apparent dips and structure sections of folded strata
e. Geometrical construction of folds
f. Trigonometric solution of fault problems
g. Solution of three-point problems and vertical fault problems by descriptive geometry
h. Solution of inclined fault problems by descriptive geometry
i. Equal-area net
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
1. Equal-area net part II
7. Determining the angle between two planes
8. Determining the orthographic projection of a line on a plane
9. Determining the angle between a line and a plane
10. Bisecting the angle between two lines
11. Bisecting the angle between two planes
12. calculating the attitude of a bed from bore hole data.

**Engineering Geology:**

Five geological maps to demarcate and evaluate suitable sites for engineering projects for Tunnels and Dam construction.

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**Paper 4: Remote Sensing and Image Interpretation, Photogrammetry .**

- 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 matchline.
- Construction of stereograms
- 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, shales and limestones. 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.
- Interpretation of multi band imagery in individual bands and FCC
- Interpretation of satellite imageries for land use/land cover.
- Interpretation of Thermal imagery data.
- Digital Image Processing (using – number matrix): enhancement, manipulation and classification.
- Demonstration lab only: of digital image processing on Computer using free software and data available in book by Mather Paul M., (2004), Computer Processing of Remotely Sensed Images- An Introduction.,3rd ed., John Wiley.

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The distribution of marks will be as follows

Journal : 20
Viva and Field Work: 20
Experiments : 160 (40 marks per practical)
Total Marks : 200