Fergusson College (Autonomous)
Pune

Curriculum for

T. Y. B. Sc. Geology

With effect from June 2021

Fergusson College (Autonomous), Pune
Structure of T. Y. B. Sc. (Geology)
Under CBCS pattern (2019) effective from June 2021

Sem.	Paper No.	Course Code	Title	Credits	CE Max Marks	ESE Max Marks	Total Max Marks
V	DSE-1A	GLY3501	Mineralogy	2	50	50	100
	DSE-1B	GLY3502	Engineering Geology	2	50	50	100
	DSE-2A	GLY3503	Structural Geology	2	50	50	100
	DSE-2B	GLY3504	Geology of India I	2	50	50	100
	DSE-3A	GLY3505	Geomorphology and Remote sensing	2	50	50	100
	DSE-3B	GLY3506	Hydrogeology	2	50	50	100
	DSE-1	GLY3507	Geology Practical - I	2	50	50	100
	DSE-2	GLY3508	Geology Practical - II	2	50	50	100
	DSE-3	GLY3509	Geology Practical - III	2	50	50	100
	SEC-1	GLY3511	Techniques in Sedimentology	2	50	50	100
	SEC-2	GLY3512	Gemmology	2	50	50	100
			Total Credits	**22**			**1100**
VI	DSE-4A	GLY3601	Economic Geology	2	50	50	100
	DSE-4B	GLY3602	Oceanic and atmospheric sciences	2	50	50	100
	DSE-5A	GLY3603	Igneous and Metamorphic Petrology	2	50	50	100
	DSE-5B	GLY3604	Geology of India II	2	50	50	100
	DSE-6A	GLY3605	Petroleum Geology	2	50	50	100
	DSE-6B	GLY3606	Geophysical Prospecting	2	50	50	100
	DSE-4	GLY3607	Geology Practical IV	2	50	50	100
	DSE-5	GLY3608	Geology Practical V	2	50	50	100
	DSE-6	GLY3609	Geology Practical VI	2	50	50	100
	SEC-3	GLY3611	Groundwater development and management	2	50	50	100
	SEC-4	GLY3612	Geological field methods	2	50	50	100
			Total Credits	**22**			**1100**

T. Y. B. Sc. Geology Semester 5		
Title of the Course and Course Code	**MINERALOGY (GLY3501)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall principles associated with optics, physical and optical mineral properties.	
CO2	Compare various mineral groups on the basis of physical and optical mineral properties along with their paragenesis.	
CO3	Apply the knowledge of minerals to understand their formation processes.	
CO4	Classify crystals into different systems.	
CO5	Determine minerals on the basis of optical characters.	
CO6	Compile mineral data by using physical and optical properties.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Crystallography, Optics and non-silicate minerals** **Crystallography** Definition of a crystal. External and internal imperfections in crystals, Growth of crystals in cavities, Study of Cubic system (Type Pyrite & Type Tetrahedrite), Study of Hexagonal system (Type Calcite, Type Quartz & Type Tourmaline), Twinning: Definition, causes, parts of twins, types of twins, laws of twinning. **Optics** Refractive index and its comparison with Becke line, shadow method and immersion method, Scheme of Pleochroism, Phenomemon of isotropism, anisotropism, extinction and interference colours, Accessory plates: Mica plate, Gypsum plate and quartz wedge, Sign of elongation in minerals, Uniaxial and biaxial indicatrices **Study of the following non-silicate minerals with respect to their chemical composition, properties and uses** Oxides: Ilmenite, Rutile and Limonite, Sulphides: Sphalerite, Galena, Sulphates: Gypsum and Baryte, Carbonates: Aragonite, Rhodochrosite and Siderite, Phosphates: Apatite, Monazite, Halides: Fluorite and Halite	**18**
II	**Study of silicate mineral groups** with reference to their silicate structure, chemical composition, physical & optical properties, paragenesis and alteration products - Olivine group, Pyroxene group, Amphibole group, Mica group, Clay mineral group, Feldspar group, Felspathoid group, Garnet group, Aluminosilicate group	**18**

References:

1. Berry and Mason (1961) Mineralogy. W. H. Freeman & Co.
2. Perkin D. (2010) Mineralogy, Pearson
3. Deer, Howie and Zussman (1996) Introduction to Rock forming Minerals, Pearson
4. Kerr, B.F., (1995) Optical Mineralogy 5th Ed. McGraw Hill, New York
5. Dana, E. S. and Ford, W. E., (2002) A textbook of Mineralogy (Reprints).
6. Read, H. H., (1968) Rutley's Element of Mineralogy (Rev. Ed.), Thomas Murby and Co.

T. Y. B. Sc. Geology Semester 5		
Title of the Course and Course Code	**Engineering Geology (GLY3502)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the concepts of engineering geology and outline the applications of geology in engineering projects.	
CO2	Discuss various engineering properties of rocks and aggregates.	
CO3	Apply the knowledge of various engineering properties of rocks in engineering projects.	
CO4	Explain the types of raw materials used in engineering projects.	
CO5	Evaluate data related to engineering classification of rocks.	
CO6	Compile geological data based on various case studies related to site selection of engineering structures.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Engineering properties and classification of rocks** **Engineering properties of rocks:** Introduction to Engineering Geology, Applications of geology in engineering projects, Importance of weathering and clay formations, Engineering properties rocks, Factors controlling the engineering properties of rock **Engineering classification of rock:** Rock Quality Designation (RQD), Rock Mass Rating System (RMRS), Rock Structure Rating (RSR), Rock Quality Index System (Q-System), Geological Strength Index (GSI) and Rock Mass Cutting Index (RMCI), Stability of slopes	**18**
II	**Geological factors for site selection of various infrastructures** **Tunnels:** Types of tunnels and geological factors affecting tunneling, Overburden, Case study **Dams and Reservoirs:** Types of dams and reservoirs, Geological factors for site selection of dam and reservoir, Case study **Bridges:** Types of bridges, Geological factors for site selection of bridges, Case study **Ground improvement and preventive measures**	**18**

References:

Books Recommended:

1. Gokhale, K. V. G. (2006) Principles of Engineering Geology, BS Publication
2. Krynine, D. P. and Judd, W. R. (2005) Principles of Engineering Geology and Geotechniques, CBS Publishers & Distributors.
3. Blyth, F. G. H. and M. H. de Freitas (1984) Geology for Engineers, Butterworth Heinemann Title
4. Engineering Geology, (2013): Parbin Singh, S. K. Kataria & Sons
5. Ries, H. and T. L. Watson, (1949) Elements of Engineering Geology, New York, John Wiley & Sons, Inc.
6. Tony Waltham (2009) Foundations of Engineering Geology, Taylor, and Francis.
7. Chenna Keshvallu (2018) Textbook of Engineering Geology, Laxmi Publications.

T. Y. B. Sc. Geology Semester 5		
Title of the Course and Course Code	**Structural Geology (GLY3503)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Recall description associated with various structures and basic concepts of plate tectonics.	
CO2	Compare different types of rock deformations.	
CO3	Apply the mechanical principles to understand formation of structures.	
CO4	Analyse the structural data.	
CO5	Evaluate the structural data.	
CO6	Prepare and validate the field structural data by using various structural analyses.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Rock Deformation I** Fundamental concepts of deformation, Factors controlling rock deformation, Definition of plastic, ductile and brittle deformation, Structural levels, brittle, ductile, brittle-ductile transition, natural examples, Stress & Strain ellipsoid, Behaviour of different minerals under stress, Behaviour of rocks in confined and unconfined conditions	**18**
II	**Rock Deformation II** Mechanisms of brittle deformation - Fractures and faults, Mechanisms of plastic deformation - Folds and Folding, Foliation and cleavage, Lineation and Linear structures, Shear zones - Brittle, Semi brittle, Ductile, Descriptive Analysis of structures - fault, joint and fold analysis, geometric analysis of folds, Analysis of deformation history from deformed rocks	**18**

References:

1. Billings, M. P. (1942) Structural Geology, Prentice Hall,
2. George H. Davis, Stephen J. Reynolds and Chuck Kluth (1984) Structural Geology of Rocks and Regions, John Wiley.
3. R. G. Park (1982) Foundations of Structural Geology, Blackie

T. Y. B. Sc. Geology Semester 5		
Title of the Course and Course Code	**Geology of India I (GLY3504)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Recall principles of stratigraphy, geological time scale and elements of continents and oceans.	
CO2	Explain the criteria used in developing the Precambrian Stratigraphy of India.	
CO3	Classify cratons, mobile belts and platform basins of India on the basis of lithological and stratigraphic characters.	
CO4	Compare various cratons, mobile belts and platform basins of India.	
CO5	Determine economic importance of Precambrian stratigraphic units of India.	
CO6	Prepare a report on rock samples collected from various stratigraphic horizons.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Indian and World Precambrian History and Precambrian rocks of Peninsular India** World Precambrian history in brief - Cratons and mobile belts of the world, General review of Indian Stratigraphy, Cratons of India and associated Proterozoic basins Craton wise broad stratigraphy, correlation and other aspects - Dharwar Craton, Singbhum - Odisha Iron Ore Craton, Central Indian Craton / Bastar Craton, Aravalli Craton, Bundelkhand Craton	**18**
II	**Precambrian rocks of Extra-Peninsula, Precambrian mobile belts and Precambrian sedimentary basins of India** **Precambrian rocks of Extra-Peninsula -** Tectono-stratigraphic divisions of Himalaya, Vaikrita Group, Juthog Group and Shali Group **Precambrian mobile belts of India -** Eastern Ghat Mobile Belt, Satpura Mobile Belt / CITZ (Central Indian Tectonic Zone), Pandyan Mobile Belt **Stratigraphy and Economic Importance of -** Aravalli Supergroup, Delhi Supergroup, Vindhyan Supergroup, Cuddapah Supergroup, Kaladgi Supergroup, Chhattisgarh Supergroup	**18**

References:

1. Ramakrishnan M, and Vaidynadhan, R (2010) Geology of India, Geological Society of India Publication, Bangalore. Vol. I
2. Valdiya K. S. (2010) The Making of India: Geodynamic Evolution, Springer
3. Ravindrakumar (2018) Fundamentals of Historical Geology and Stratigraphy of India, Newage Publications.
4. Krishnan, M. S. (1982) Geology of India and Burma, 6th Edition. CBS Publ.

T. Y. B. Sc. Geology Semester 5		
Title of the Course and Course Code	**Geomorphology and Remote Sensing (GLY3505)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Identify various photo recognition elements from remotely sensed data.	
CO2	Discuss various geomorphic features, lithologies and structural elements from remotely sensed data.	
CO3	Apply remote sensing principles and photo recognition elements to identify various features.	
CO4	Analyze remotely sensed data to draw conclusions regarding geological history of an area.	
CO5	Compare between different types of remotely sensed data and evaluate its utility.	
CO6	Assemble remote sensing and geomorphological data and prepare a report.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Geomorphology and Principles of Remote Sensing** **Geomorphology -** Introduction to geomorphic concepts, Landforms: role of lithology, endogenous and exogenous processes, climatic and tectonic forces, Study of different landforms, Introduction to Geomorphic Indicators of Active Tectonics (GAT indices) **Principles of Remote Sensing -** Definition, history, types of remote sensing systems, Energy source and radiation principles, Energy interactions in the atmosphere, with the earth, spectral reflectance of vegetation, soil & water; data acquisition & interpretation	**18**
II	**Photogeology, Satellites and Satellite data** **Photogeology -** Aerial Photography, Classification and planning of aerial photographs, Discrepancies in aerial photographs, Geometric characteristics of aerial photos, Stereoscopy, Photo recognition elements, Advantages and limitations of aerial photos, Photo-geological interpretations of lithology and structure, Use of drones for remote sensing **Satellites and Satellite data** - Introduction to Satellites, Sensors & their applications, Brief history, Types of Satellites (Orbital Characteristics, Sensors and applications with reference to latest IRS & Landsat: Landsat 7 and 8, IRS satellites - Oceansat, Cartosat, Resourcesat, IRNSS), Scanners - Hyperspectral Scanners, Active remote sensing systems - RADAR and LIDAR (Principles & applications)	**18**

References:

1. Kale V. S. and Gupta A. (2001) Introduction to Geomorphology, Orient Longman
2. Thornbury W. D. (1954), Principles of Geomorphology, Wiley
3. Lillesand T. M., Kiefer R. W. and Chipman J. (2015) Remote Sensing and Image Interpretation, Wiley
4. Drury S. A. (1990) A Guide to Remote Sensing - Interpreting Images of Earth, Oxford Science Publications
5. Pandey S. N. (2001) Principles and Applications of Photogeology, New Age International

6. https://www.usgs.gov/core-science-systems/nli/landsat
7. https://www.iirs.gov.in

T. Y. B. Sc. Geology Semester 5		
Title of the Course and Course Code	**Hydrogeology (GLY3506)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the status of groundwater in India and the world.	
CO2	Discuss basic concepts related to fluid motion in porous media.	
CO3	Illustrate the concept of aquifers and their boundaries.	
CO4	Compare the status of groundwater in various physiographic divisions of India.	
CO5	Determine appropriate techniques for hydrogeological survey.	
CO6	Perform hydrogeological surveys and prepare field reports.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to hydrogeology, groundwater accumulation, movement and aquifers** – Definition - Hydrology, Hydrogeology, Groundwater and the hydrologic cycle, Groundwater as a resource, Groundwater crises, Global groundwater scenario, Indian groundwater scenario and scope and groundwater development in India, Vertical distribution of groundwater, Origin of groundwater and rock properties affecting groundwater, Groundwater accumulation, Groundwater movement (Darcy's law), Aquifers, Geologic formations as aquifers, Types of aquifers, Springs and conditions for formation of springs, types of springs, Groundwater and surface water - Base flows, stream flow	**18**
II	**Groundwater Problems, Field Techniques and Groundwater in India** **Ground Water Problems -** Introduction to water quality and groundwater pollution, Saline water ingress and remedial measures, Groundwater overexploitation, **Field Techniques -** Groundwater level measurement and analysis, use of isotope studies, Weather parameters and measurement and analysis, Introduction to Pumping tests and slug tests, Introduction to groundwater modelling techniques **Groundwater in India -** Groundwater provinces of India (Case studies), Groundwater agencies in India (Government agencies and NGO's) and Groundwater assessment in India	**18**

References:

1. Todd D. K. (2007) Groundwater Hydrology, Wiley.
2. Freeze R. A. and Cherry J. A. (1979) Groundwater, Prentice Hall.
3. Fetter C. W. (2018) Applied Hydrogeology, Waveland Press.
4. Brassington R. (2017) Field Hydrogeology, Wiley Blackwell

5. Raghunath, H. M. (1987) Groundwater, New Age International
6. www.acwadam.org publications

T. Y. B. Sc. Geology Semester 5		
Title of the Course and Course Code	**Geology Practical I (GLY3507)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Identify megascopic and microscopic and describe various engineering properties of rocks.	
CO2	Infer standard parameters from twinned crystals	
CO3	Classify different crystals on the basis of hemimorphic and hemihedral forms	
CO4	Compare between crystals within Cubic system and Hexagonal system.	
CO5	Determine RQD from given data and critique about site selection for construction of engineering structures from geological data.	
CO6	Generate the axial ratios of crystals from given data.	

Practicals related to GLY3501 Mineralogy

Study of megascopic properties of minerals
Study of microscopic properties of minerals
Optics - R. I. and Sign of elongation
Crystallography - Study of Cubic System Type - Pyrite and Tetrahedrite
Crystallography - Study of Hexagonal System Type Calcite, Quartz and Tourmaline
Study of Twin Crystals and Axial Ratios

Practicals related to GLY3502 Engineering Geology

Site suitability for construction of large engineering projects.
Preparation of subsurface map, correlation and interpretation for construction of large engineering Projects - I
Preparation of subsurface map, correlation and interpretation for construction of large engineering projects - II
Study of physical and engineering properties of rocks.
Any other related two experiments.

T. Y. B. Sc. Geology Semester 5		
Title of the Course and Course Code	**Geology Practical II (GLY3508)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe various structural features on the basis of geometrical data.	
CO2	Compute reduced level of a bore hole from given data.	
CO3	Interpret given geological map of an area and construct a cross section.	
CO4	Compare the stratigraphy of various Precambrian units of India	
CO5	Measure plunge and rake of a linear structural feature by geometric and stereographic methods.	
CO6	Prepare a geological map from given data.	

Practicals related to GLY3503 Structural Geology

Study of geological maps with folded beds - I
Study of geological maps with folded beds - II
Study of geological maps with folded and faulted beds
Completion of outcrops - I
Completion of outcrops - II
Stereographic Problems
Structural Problems Type - 2 (A and B)
Structural Problems Type - 3
Structural Problems Type - 4 (Three Point Problem)

Practicals related to GLY3504 Geology of India I

Study of maps showing geographical distribution of the various Precambrian stratigraphic units of India
Any other related two experiments.

T. Y. B. Sc. Geology Semester 5		
Title of the Course and Course Code	**Geology Practical III (GLY3509)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Identify relation between rainfall and groundwater levels from given data	
CO2	Compute the scale of aerial photographs and base flow contribution from given stream flow data	
CO3	Examine different remote sensing data using photo recognition elements and calculate specific capacity of wells from pumping test data	
CO4	Analyze lineament orientations from given remote sensing data and groundwater quality using various methods.	
CO5	Measure different morphometric parameters in a given drainage basin and determine recharge and discharge areas of groundwater from given data.	
CO6	Compile observations from satellite images and aerial photos and construct water table contours from well inventory data.	

Practicals related to GLY3505 Geomorphology and Remote Sensing

Morphometry - Drainage basin analysis
Problems related to scale of aerial photographs and relief displacement (Type A to E)
Geomorphic, lithological and structural interpretations from aerial photographs
Interpretation of Satellite Images
Lineament analysis

Practicals related to GLY3506 Hydrogeology

Preparation of hydrographs using rainfall, water level data or spring discharge data
Preparation of water table contours to understand flow direction of groundwater and to demarcate recharge and discharge areas
Pumping test analysis for specific capacity of wells (Slichter's method)
Groundwater quality analysis using Piper's plot
Analysis of stream flow data for base flow calculations
Any other related two experiments.

T. Y. B. Sc. Geology Semester 5		
Title of the Course and Course Code	**Techniques in Sedimentology (GLY3511)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe various techniques in sedimentology.	
CO2	Discuss the systematic approach to field log preparation.	
CO3	Illustrate the concept of granulometric, provenance and paleocurrent studies.	
CO4	Analyse the given sedimentological data.	
CO5	Evaluate the sedimentological data to determine depositional environment and source area.	
CO6	Prepare and validate the given sedimentological data by using bivariant and multivariant plots.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Techniques in Sedimentology - I** Systematic approach to field log preparation, Granulometric analysis, graphical representation and interpretation of grain size data, Provenance studies by Heavy Mineral, Modal and Geochemical analyses, graphical representation and interpretation	**18**
II	**Techniques in Sedimentology - II** Paleocurrent analysis, field data collection, graphical representation and interpretation, Analysis using basic software	**18**

References:

1. Tucker, M. E. (1988) Techniques in Sedimentology, Blackwell Scientific Publications, Boston
2. Tucker, M. E. (2011) Sedimentary Rocks in the Field: A Practical Guide, Wiley-Blackwell
3. Nichols Gary (2009) Sedimentology and Stratigraphy, Wiley-Blackwell

T. Y. B. Sc. Geology Semester 5		
Title of the Course and Course Code	**Gemmology (GLY3512)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe the attributes of gemstones	
CO2	Discuss the use of different gem instruments in identification of the gemstones	
CO3	Examine the treatments used in the gemstones to enhance their attributes	
CO4	Compare various gemstones based on their physical and optical properties.	
CO5	Discriminate between synthetic and natural gemstones	
CO6	Organize various gemstones into different groups based on their physical and optical properties	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction and Gem Species** Attributes, formation and basic properties of gems, Gem instruments and their use in gemstone identification, Causes of colours in gemstones, Description of typical gem species with respect to their varieties (colour wise), Chemical composition, Crystal system, Physical and optical properties, Characteristic inclusions and Geographical Occurrences	**18**
II	**Diamonds, Gem Synthesis, Treatments and Gem Identification** Treatments of gemstones and their detection, Imitation and composite stones, Gem synthesis and distinction between Synthetic and Natural gemstones, Advance Techniques of gem Identification, Opaque gem varieties, Rare gemstones, Organic gemstones, Diamonds	**18**

References:

1. Anderson B.W (2011) Gem Testing, Read books Ltd.
2. Karanth RV (2000) Gem & gem Industry in India (Memoir 45), Geological society of India, Bangalore
3. Read, P.G (2005) Gemmology, Elsevier / Butterworth - Heinemann
4. Bruton Eric (1978) Diamonds, Chilton Book Company

T. Y. B. Sc. Geology Semester 6		
Title of the Course and Course Code	**Economic Geology (GLY3601)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe various ore minerals on the basis of their physical and chemical properties.	
CO2	Discuss various processes involved in ore formation.	
CO3	Outline the information about the geographical occurrence of different ores in India.	
CO4	Compare various metallic and non-metallic deposits.	
CO5	Justify occurrence of metallic and non-metallic deposits in an area on the basis of geological parameters.	
CO6	Prepare a report about metallic and non-metallic deposits collected from the field.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Basics of economic geology and processes of formation of mineral deposits -** Introduction: Ore, gangue, tenor, syngenetic and epigenetic deposits, Classification of metalliferous and non-metalliferous deposits, Processes of formation of mineral deposits: Primary Processes- Magmatic concentration and Hydrothermal Process; Secondary Processes - Oxidation and Supergene enrichment, Evaporation, Residual concentration and Mechanical concentration	**18**
II	**Study of metallic and non-metallic deposits:** Study of following metallic deposits with reference to their mode of occurrence, mineralogy, properties, uses, geological and geographical distribution: Precious metals, non-ferrous metals and iron and ferro alloy metals Study of following non-metallic mineral deposits with reference to mode of occurrence, properties and uses: Industrial and manufacturing materials, chemical minerals, fertilizer minerals, abrasives & abrasive minerals and refractory minerals Study of Radioactive minerals Coal - origin, varieties, mode of occurrence, coal deposits in India (Raniganj and Bokaro), coal fields of Maharashtra	**18**

References:

1. Jeason and Bateman (1981) Economic mineral deposits, John Wiley and Sons.
2. Gokhale &Rao (1978) Ore deposits of India, Thomson press (India) limited.
3. Umeshwar Prasad (2003) Economic Geology, Satish Kumar Jain, CBS Publishers and Distributers.
4. Krishnaswamy, Subbier (1979) *India's mineral resources*, 2nd edition: New Delhi, Oxford and IBH Publishing
5. D. N. Wadia (1966) India's Minerals, National Book Trust
6. Robert L. Bates (1969) Geology of the Industrial Rocks & Minerals, Dover Publications
7. Economic mineral deposits of India by Umate (IBM)
8. Park & McDermitt (1997) Economic Ore Deposits

9. Reports of IBM, DGM, GSI and MECL

T. Y. B. Sc. Geology Semester 5		
Title of the Course and Course Code	**Oceanic and Atmospheric Sciences (GLY3602)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Define structure of atmosphere and oceans.	
CO2	Discuss basic concepts related to oceanic and atmospheric circulation.	
CO3	Illustrate the concept of Coupled Ocean-Atmosphere Systems.	
CO4	Analyze the types of clouds and oceanic floor features.	
CO5	Review greenhouse effect, climate change and related concepts.	
CO6	Compile different types of climate change related data.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Oceans and Atmosphere** **Oceans -** Hypsography of ocean floor, Physical and chemical properties of sea water and their spatial variation, Residence time of elements in sea water, Introduction to thermohaline circulation and oceanic conveyor belt, Major water masses of the world's oceans **Atmosphere -** Structure of atmosphere, Greenhouse gases and effect, Cloud formation and precipitation processes, Insolation and heat budget of Earth	**18**
II	**Coupled Ocean-Atmosphere Systems** El-Niño Southern oscillations (ENSO), General weather system of Indian subcontinent - Monsoon, Jet stream, Cyclones, Western disturbances, Severe local convective systems, Distribution of precipitation over India	**18**

References:

1. Surendra Kumar (2011) R Gupta's Popular Master Guide: CSIR-UGC NET / JRF Earth, Atmospheric, Ocean and Planetary Sciences, Ramesh Publishing House.
2. Wallace, J. M. and Hobbs, P. V. (2006)Atmospheric Sciences: An introductory Survey, Elsevier Science,
3. Albert Defant (1961) Physical Oceanography, Pergamon, New York

T. Y. B. Sc. Geology Semester 6		
Title of the Course and Course Code	**Igneous and Metamorphic Petrology (GLY3603)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Recall textural and mineralogical characters of igneous and metamorphic rocks.	
CO2	Catagorize igneous and metamorphic rocks on the basis of physical and optical properties.	
CO3	Examine and classify igneous and metamorphic rocks.	
CO4	Analyze ACF and Norm data	
CO5	Compare different metamorphic facies, igneous rock kindreds and provinces.	
CO6	Prepare a report about the rock samples collected from the field.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Igneous Petrology** Types of Magma: Primary and derivative, Crystallization of Magma: Unicomponent magma, Bicomponent magma, Phase rule, Eutectic Crystallization, Solid solution series, Binary magma with an incongruent melting compounds: Leucite - silica system. Ternary system: Albite - Anorthite - Diopside system, Processes of Magmatic Differentiation, Role of volatile constituents in differentiation of magma, Classification of igneous rocks - Complexity in classification, Shand's classification, CIPW classification, IUGS (plutonic, volcanic) classifications, Petrographic Provinces, Rock Kindreds and Description of Igneous Rocks, Migmatites	**18**
II	**Metamorphic Petrology** Metamorphism as a process and types of metamorphism, Metamorphic Reconstitution, Barrowian zones and Metamorphic facies, Thermal Metamorphism, Dynamic / Cataclastic Metamorphism, Regional Metamorphism, Pnuematolysis or Metasomatism	**18**

References:

1. Turner and Verhoogen (1951) Igneous and metamorphic Petrology, McGraw-Hill.
2. Elher and Blatt (1982) Igneous, metamorphic and sedimentary Rocks, Freeman.
3. John D. Winter (2010) Principles of Igneous and Metamorphic Petrology, Prentice Hall.
4. Tyrrell G. W. (1978) Principles of Petrology, Springer
5. Bruce Yardley and Clare Warren (1991) Introduction to Metamorphic Petrology, Longman Scientific & Technical
6. M. Wilson (2007) Igneous Petrogenesis, Springer

T. Y. B. Sc. Geology Semester 6		
Title of the Course and Course Code	**Geology of India II (GLY3604)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Recall principles of stratigraphy and geological time scale giving special emphasis on Phanerozoic Eon.	
CO2	Discuss the criteria used in developing the Phanerozoic Stratigraphy of India.	
CO3	Classify Palaeozoic, Mesozoic and Cenozoic Systems or Groups on the basis of lithology, stratigraphic characters and boundary problems.	
CO4	Compare various events during Phanerozoic Eon.	
CO5	Determine the economic importance of rocks associated with various Phanerozoic basins of India.	
CO6	Prepare a report on rock samples collected from various stratigraphic horizons.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Phanerozoic Stratigraphy and Palaeontology Stratigraphic Boundary Problems -** Introduction to Geological systems with reference to their global type area, Precambrian - Cambrian boundary, Permo - Triassic Boundary, Cretaceous - Palaeogene Boundary, Palaeogene - Neogene Boundary **Palaeontology -** Morphology, Classification & distribution of Graptolites, Gondwana Flora, Mass extinctions, **Phanerozoic Stratigraphy of Extra - Peninsular India -**Classification, lithological succession and fossil content	**18**
II	**Phanerozoic Stratigraphy of Peninsular India -** Palaeozoic Formations of Peninsular India, Mesozoic Formations of Peninsular India, Cenozoic Formations of Peninsular India, Deccan Volcanic Province, Stratigraphy of Maharashtra in brief	**18**

References:

1. Vaidynadhan, R and Ramakrishnan, M (2010) Geology of India, Geological Society of India Publication, Bangalore. Vol. II
2. Valdiya K. S. (2010) The Making of India: Geodynamic Evolution, Springer
3. Ravindra Kumar (2018) Fundamentals of Historical Geology and Stratigraphy of India, New Age Publications.
4. Krishnan, M. S. (1982) Geology of India and Burma, 6th Edition. CBS Publ.

T. Y. B. Sc. Geology Semester 6		
Title of the Course and Course Code	**Petroleum Geology (GLY3605)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe occurrence and distribution of petroleum within rocks.	
CO2	Explain the origin, migration and accumulation of petroleum.	
CO3	Classify various reservoirs and traps.	
CO4	Categorise various types of petroliferous basins of India.	
CO5	Evaluate geological occurrences of petroleum.	
CO6	Organise the geological data from various petroliferous basins.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Petroleum Geology - I -** Occurrence of petroleum, nature of source rock, Reservoir and Traps, Origin, migration and accumulation of petroleum	**18**
II	**Petroleum Geology - II -** Classification and composition of petroleum products Physical properties of petroleum, composition of biomass, Kerogen - Composition and types, Petroliferous basins of India and the world	**18**

References:

1. Levorsen, A. I., (2004) Geology of Petroleum, CBS Publishers and Distributors
2. Selley, R. C., (1998) Elements of Petroleum Geology: W.H. Freeman & Company, New York
3. Deshpande, B. G. (2009) The world of Petroleum, New Age International, New Delhi

T. Y. B. Sc. Geology Semester 6		
Title of the Course and Course Code	**Geophysical Prospecting (GLY3606)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Recall fundamental concepts associated with gravity, magnetism, electricity and wave motion.	
CO2	Summarize various geophysical properties of the earth related to gravity, magnetism, electricity and wave motion.	
CO3	Apply geophysical concepts in prospecting of economically important deposits.	
CO4	Analyse and calculate various geophysical properties of the earth using geophysical data.	
CO5	Evaluate the geophysical character of rocks.	
CO6	Compile and validate geophysical data using field observations.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Gravity and Magnetic Prospecting of the Earth** **Gravity Prospecting -** Law of Universal Gravitation- concept, gravitational acceleration, Gravitational potential, mass and density distribution in the earth, Gravitational prospecting - Measurement of gravity - instruments and their principles, Corrections of gravity measurements, Representation and interpretations of gravity measurements **Magnetic Prospecting -** Physics of magnetism, Geomagnetism & Rock magnetism, Palaeomagnetism - Concept and applications, Magnetic Prospecting - Measurement of magnetism - instruments and their principles, representation and interpretation of magnetic data	**18**
II	**Electric and Seismic Prospecting of the Earth** **Electric Prospecting -** Electrical Principles, Electrical Properties of earth- Electric conductivity in the earth, Electrical prospecting - Introduction to Natural potential and currents, Self potential, Resistivity, VES, Induced polarization, telluric currents **Seismology and Seismic Prospecting -** Seismic waves - Types, characters, Seismic wave propagation - Huygen's principle, Fermat's principle, critical reflection, Seismic Prospecting - Reflection seismology - reflection at horizontal surface, reflection at inclined surface, concept of seismic noise	**18**

References:

1. Ramchandra Rao (1975) Outlines of geophysical prospecting: a manual for geologists, University of Mysore.
2. William Lowrie (1997) Fundamentals of Geophysics, Cambridge University Press
3. Dobrin M. B. (1960) Introduction to Geophysical Prospecting, Mcgraw Hill.

T. Y. B. Sc. Geology Semester 6		
Title of the Course and Course Code	**Geology Practical IV (GLY3607)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Identify economic and industrial minerals in hand specimens and name major oceanic and atmospheric current systems.	
CO2	Give examples of occurrence of economic deposits in India.	
CO3	Classify different economic minerals according to their chemical composition.	
CO4	Compare geological occurrence of different economically important deposits and analyse different types of meteorological data.	
CO5	Determine the use of different economically important deposits in industries.	
CO6	Construct bathymetric profiles from given bathymetric charts.	

Practicals related to GLY3601 Economic Geology

Megascopic study of ore minerals - I
Megascopic study of ore minerals - II
Megascopic study of industrial minerals - I
Megascopic study of industrial minerals - II
Preparation of ore mineral maps of India for the following:
Fe, Mn, Cr, Cu, Pb, Zn & Al.

Practicals related to GLY3602 Oceanic and Atmospheric Sciences

Preparation of isotherms
Preparation of isobars
Analysis of rainfall data
Study of the oceanic conveyor belt with major current systems
Construction and study of (ocean) bathymetric profile
Any other related two experiments.

T. Y. B. Sc. Geology Semester 6		
Title of the Course and Course Code	**Geology Practical V (GLY3608)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall different rock textures and structures.	
CO2	Categorize various megascopic and microscopic rocks using physical and optical properties.	
CO3	Examine different rocks and plant fossils in hand specimen.	
CO4	Compare the stratigraphy of various Phanerozoic units of India.	
CO5	Determine nature of protolith by ACF diagrams.	
CO6	Perform CIPW Norm calculation for silica saturated igneous rocks.	

Practicals related to GLY3603 Igneous and Metamorphic Petrology

Megascopic study of various igneous rocks.
Megascopic study of various igneous structures.
Microscopic study of various igneous rocks.
Microscopic study of various textures and structures of igneous rocks
Megascopic study of various metamorphic rocks.
Microscopic study of various metamorphic rocks.
Problems related to CIPW Norm calculation for silica saturated igneous rocks
Plotting of Chemical Composition of Metamorphic rocks on ACF diagrams.

Practicals related to GLY3604 Geology of India II

Study of plant fossils associated with Gondwana Sequence of rocks.
Study of maps showing geographical distribution of the various Phanerozoic Stratigraphic units of India
Any other related two experiments.

T. Y. B. Sc. Geology Semester 6		
Title of the Course and Course Code	**Geology Practical VI (GLY3609)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Identify various subsurface structures from given seismic profiles	
CO2	Infer the occurrence of petroleum deposits from given lithological data	
CO3	Classify the rocks on the basis of porosity and permeability of rocks	
CO4	Compare petroliferous basins of India.	
CO5	Determine subsurface structure on the basis of geophysical data.	
CO6	Construct structural contours map, isopach maps and fence diagram for demarcation of petroliferous horizons	

Practicals Related to GLY3605 Petroleum Geology Study of structural contours and isopach maps Construction of structural contours and isopach maps Categorisation of petroliferous basins of India Construction of Fence diagram for demarcation of petroliferous horizon. Analysis related to porosity, permeability and fluid saturation.
Practicals related to GLY3606 Geophysical Prospecting Numerical problems related to gravity data Numerical problems related to magnetic data Resistivity survey and data analysis - I Resistivity survey and data analysis - II Study of seismic profiles Any other related two experiments.

T. Y. B. Sc. Geology Semester 6		
Title of the Course and Course Code	**Groundwater Development And Management (GLY3611)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the status of groundwater in India and the world.	
CO2	Discuss basic concepts related to groundwater development and management.	
CO3	Illustrate the concept of managed aquifer recharge, participatory groundwater management and springshed development.	
CO4	Compare the status of groundwater in various physiographic divisions of India.	
CO5	Determine appropriate techniques for groundwater development and management.	
CO6	Perform hydrogeological surveys and prepare field reports.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Groundwater development -** Groundwater provinces of India, Concept of watershed and watershed development measures, Integrated Watershed Management Programme (IWMP), Managed Aquifer Recharge**,** Types of recharge methods: Water spreading methods, Recharge through Pits & Shafts, Recharge through wells, Rain water harvesting, Groundwater recharge methods in Maharashtra	**18**
II	**Groundwater management -** Concept of groundwater management-integrating aquifers and society, Quantifying groundwater availability, demand and supply, Groundwater balance and budgeting, Typology of aquifers: Scale and diversity, Competition and conflict over groundwater, Institutions and groundwater as common property resource, Participatory Groundwater Management (PGWM) and springshed management, Groundwater legislation	**18**

References:

1. Todd D. K. (2007) Groundwater Hydrology, Wiley.
2. Brassington R. (2017) Field Hydrogeology, Wiley Blackwell.
3. Raghunath, H. M. (1987) Groundwater, New Age International.
4. Karanth, K. R. (1987) Groundwater Assessment Development and Management, Tata McGraw-Hill Education.
5. https://www.india.gov.in/integrated-watershed-management-programme-ministry-rural-development
6. http://mowr.gov.in publications
7. http://gsda.maharashtra.gov.in publications
8. www.acwadam.org publications

T. Y. B. Sc. Geology Semester 6		
Title of the Course and Course Code	**Geological Field Methods (GLY3612)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	List different standard lithological symbols and colour codes for preparation of geological maps.	
CO2	Interpret toposheets, remote sensing and other resources for reconnaissance.	
CO3	Demonstrate the use of field equipments.	
CO4	Analyse different types of geological data and maps.	
CO5	Measure attitude, thickness, orientations of different features observed in the field.	
CO6	Write a report on different minerals, rocks, fossils and structural features observed during the study tour.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Field Geology -** Aim and objectives, Literature Review, Toposheet reading, Interpretation of geological data and maps, Preparation for fieldwork, field safety, logistics, navigation, Study of outcrops, Observations in the field , Introduction to geological mapping, Report writing, Bibliography	**18**
II	**Fieldwork -** 10-15 days of fieldwork in areas to study different rock types, rock structures, stratigraphic sections and different aspects of applied geology, during fieldwork students are expected to make geological observations, record data in field notes, collect samples and prepare field report	**18**

References:

1. Angela L. Coe (2010) Geological Field Techniques, Wiley Blackwell.
2. Lahee Fredrick H. (1961) Geology in the field by Robert R. Compton, John Wiley and Sons.
3. Compton Robert R. (1962) Manual of Field Geology John Wiley & Sons.
4. Dougal Jerram, Nick Petford (2011) The Field Description of Igneous Rocks, 2nd Edition, Wiley Blackwell.
5. Maurice E. Tucker (2011) Sedimentary Rocks in the Field: A Practical Guide, 4th Edition, Wiley Blackwell.
6. Norman Fry (2013) The Field Description of Metamorphic Rocks, Wiley.
7. K. R. McClay (2013) The Mapping of Geological Structures, Wiley.
8. Geological Survey of India District Resource Map Series (2001).