Fergusson College (Autonomous)

Pune

Learning Outcomes-Based Curriculum

For F. Y. B. Sc. Geology

With effect from June 2019

Program Outcomes (POs) for B.Sc. Programme	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	**Social competence:** Display the understanding, behavioural skills needed for successful social adaptation , work in groups, exhibits thoughts and ideas effectively in writing and orally.
PO4	**Research-related skills and Scientific temper:** Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	**Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Performing dependentlyand also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields.Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

PSO No.	Program Specific Outcomes (PSOs) Upon completion of this programme the student will be able to
PSO1	**Academic competence:** (i) Describe the knowledge of physical and chemical properties of lithosphere and hydrosphere (minerals, rocks, soils and water etc.). (ii) Demonstrate the knowledge of geologic time and earth's history; dynamics of crustal materials with respect to Plate Tectonics theory, outline of regional geology of India. (iii) Articulate the methods of science and explain why current scientific knowledge is both contestable and testable by further inquiry and to appraise the relationship between different science communities of practice. Pursue further learning in Geology with reasonable knowledge, skills and interest.
PSO2	**Personal and Professional Competence:** (i) Demonstrate the competence in fundamental geological skills like- identification of various minerals and rocks in hand specimens and under the microscope. (ii) Express clearly and convincingly about ideas of science and technology.
PSO3	**Research Competence** (i) Interpret analytically aerial photographs, toposheets and satellite data. (ii) Interpret geological maps and construction of cross section, collection of field data and laboratory data.
PSO4	**Entrepreneurial and Social competence** (i) Evaluate data of the societal relevance of earth systems and the processes. (ii) Apply the knowledge of geology in the fields of Engineering, Mining, Hydrogeology and other areas to solve the problems. (iii) Collaborate in various geological services with demonstration of true values of leadership, co-operation, hard work, teamwork etc. during the field works, surveys and field visits. (iv) Illustrate overall personality traits like stage daring, communication skills, presentation which is essential for future career.

Programme Structure

Year	Code	Title of Paper	No. of Credits
F.Y. B. Sc.	**Semester I**		
	GLY1101	Earth System Science	2
	GLY1102	Mineral Science	2
	GLY1103	Geology Practical - I	2
	Semester II		
	GLY1201	Palaeontology	2
	GLY1202	Petrology	2
	GLY1203	Geology Practical - II	2

Year	Name of Paper	Paper Code	Title of Paper	No. of Credits
S.Y. B.Sc.	**Semester III**			
	Theory Paper - 1	GLY2301	Principles of Stratigraphy and Sedimentation	2
	Theory Paper - 2	GLY2302	Structural Geology	2
	Practical Paper - 1	GLY2303	Geology Practical related to GLY 2301 and 2302 Practical -III	2
	Semester IV			
	Theory Paper - 3	GLY2401	Global tectonics and geodynamics ofthe lithosphere	2
	Theory Paper - 4	GLY2402	Environmental geology and geogenic disasters	2
	Practical Paper - 2	GLY2403	Geology Practical related to GLY 2401 and2402+ 4-5 Days Field Component Practical -IV	2

Year	Paper No.	Course Code	Title	Credits	CE Max Marks	ESE Max Marks	Total Max Marks
T. Y. B. Sc.	**Semester 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

Year	Paper No.	Course Code	Title	Credits	CE Max Marks	ESE Max Marks	Total Max Marks
T. Y. B. Sc.	**Semester 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

F.Y. B.Sc. Semester I		
Title of the Course and Course Code	**Earth System Science (GLY1101)**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe the origin and evolution of earth.	
CO2	Explain the interior structure of the earth and plate movements.	
CO3	Classify various types of landforms based on origin and characteristic features.	
CO4	Compare various types of earth processes.	
CO5	Evaluate various processes involved in shaping the earth.	
CO6	Compile a report on landforms studied during field work.	

Unit. No.	Title and Contents	No. of Lectures
I	**EARTH: ITS ORIGIN, AGE, INTERIOR AND PROCESSES** **Introduction**: Definition of geology, its divisions, sub-divisions and scope **Planet Earth** Origin of the Universe (Big Bang Theory), Origin of the Solar System (Nebular, Encounter and Tidal theory) Earth: Its size, shape and density. Temperature, pressure and magnetism within the earth, Present day hypsographic curve Age of the Earth: A brief account of the historical methods. Determination of age by the K/Ar, U/Th and Carbon dating methods Geological Time Scale: Concept and Criteria. The Earth's Atmosphere (Introduction to Atmospheric circulation, weather and climate changes, land-air-sea interactions, global climatic changes), Hydrosphere (Introduction to ocean currents, types and causes, significance), Lithosphere (Structure and composition) and Biosphere (Ecology and food chain) Earth's crust, mantle and core, Continental Drift: Concept and evidences- continental fit, geological and palaeontological evidences, Plate Tectonics: A brief introduction, Concept of Isostacy: Pratt's and Airy's model.	18

II	**DYNAMICS OF THE EARTH** **Geomorphic processes and landforms** Weathering, erosion and denudation Types of weathering: Mechanical – frost wedging, frost action, insolation, activities of organic life and exfoliation Chemical-hydrolysis, hydration, solution, carbonation and oxidation The dynamics of erosional and depositional landforms resulting from the action of: **River** Erosional landforms – waterfall, potholes, mesa and butte, meandering and ox-bow lake, Depositional landforms- delta and types, alluvial fans, flood plains and river terraces. **Wind** Erosional landforms - deflation and deflation armour, yardangs, mushroom rock, Depositional landforms - sand dunes and its types, loess. **Sea** Erosional landforms - sea cliff, sea cave, natural arch, sea stack, Depositional landforms- Beach and long shore drift deposits **Glaciers** Erosional landforms - Valleys (U shaped and hanging valleys), crevasse, cirque, crag and tail Depositional landforms - moraines and its types, drumlins, eskers. **Types of Mountains**: Fold, fault block, volcanic and residual. **Volcanoes**: Genesis of volcanoes, Central and fissure type of eruptions. Products of volcanoes, effects of volcanoes, earth's volcanic belts. **Earthquakes**: Definition, terminology, causes, intensity and magnitude. Recording of earthquakes (Modern recording method). Use of seismic waves and their importance in interpreting the earth's internal structure. Seismic zones. History and susceptibility of the Indian subcontinent to earthquakes. **Disasters and Disaster Management**: Disaster: Definition, types, effects, phases, prevention, mitigation and preparedness. A case study of any one Indian disaster. Disaster Management: Definition, types, warning, precautions, mitigation and management.	18

References:

1. General Geology: Radhakrishnan
2. Holmes Principles of Physical Geology: Edited by P. McL. D. Duff
3. Plate tectonics and Crustal evolution: Condie
4. Our evolving planet: Bergen, Alma Mater Fortag
5. Geomorphology and Global Tectonics: Summerfield M. A.
6. Geomorphology: Thornburry
7. Concepts of Geomorphology: Gupta and Kale

Title of the Course and Course Code	**Mineral Science GLY1102**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe various physical properties, optical properties ,crystal parameters in minerals and crystal models.	
CO2	Compare various crystals based on symmetry, symmetry functions and explain crystal systems, mineral groups based on physical and optical properties.	
CO3	Apply the understanding of physical, optical and other properties to determine the different groups and crystal systems.	
CO4	Explain industrial applications and economic importance of various minerals.	
CO5	Compare minerals on the basis of the different properties and estimate a few physical properties like hardness and specific gravity of minerals.	
CO6	Prepare a report about mineral samples collected individually during the study tour.	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**FORMATION AND PROPERTIES OF MINERALS** **Introduction:** Definition, branches and scope of mineralogy and uses of minerals. **Formation of minerals:** Introduction and description of geological processes of mineral formation; Crystallization from melt, Crystallization from Solution. (evaporation and precipitation), Crystallization from Vapour (sublimation), Metamorphic processes, Alteration and related weathering (oxidation and supergene sulphide enrichment) **Physical properties of minerals** << Colour, streak, lustre, cleavage, fracture, hardness, form and specific gravity, Methods of determining specific gravity	18

	Properties based on magnetism, electrical properties, and radioactivity, Luminescence (Phosphorescence and Fluorescence) **Optical mineralogy** Nature of light – ordinary and plane polarized light, Double refraction of light (with the help of calcite crystal), Nicol's prism and polaroids, Petrological microscope, Introduction to optical properties: – ● In plane polarized light: Colour, form, cleavage, cracks, relief, twinkling, pleochroism, In between Crossed Nicols: Isotropism, anisotropism, extinction positions (straight, oblique, symmetrical and determination of extinction angle), interference colours, twinning (simple, multiple and cross hatching). **Crystal Chemistry** Geochemical affinity & geochemical classification of elements, Isomorphism, polymorphism, pseudo morphism. Silicate structures	
II	**MINERAL GROUPS AND CRYSTALLOGRAPHY** **Mineral Groups**- Study of following mineral groups with respect to their silicate structure, chemical composition, physical and optical properties Olivine, Pyroxene, Mica, Feldspar, Silica, Amphibole **Crystallography** Definition and conditions conducive for the formation of crystals. Crystal morphology – faces, forms, edges, solid angles, interfacial angle and its measurement by contact goniometer, law of constancy of interfacial angle. Symmetry of crystals – Elements of Symmetry-Plane, axis and center of symmetry; crystallographic and geometrical symmetry. Crystallographic axes, lettering and order of crystallographic axes, parameters, axial ratio, indices, parameter system of Weiss, index system of Miller, Law of rational indices. Study of following crystallographic systems with respect to their elements of symmetry, crystallographic axes and their forms with indices. Orthorhombic (Type: Barytes), Tetragonal (Type: Zircon), Cubic (Type: Galena), Hexagonal (Type: Beryl), Monoclinic (Type: Gypsum), Triclinic (Type: Axinite)	18

References:

1. Read, H. H., 1916, Rutley's Elements of Mineralogy, 26th Edition, Thomos Murby & Co., London
2. Gribble, C. D., 1988, Rutley's Elements of Mineralogy, 27th Edition, Unwin Hyman, London
3. Dana, E. S., and Ford, W. E., 1922, Text Book of Mineralogy, John Wiley, New York,748p.
4. Deer, W. A., Howie, R. A. and Zussman, J., 2013, An Introduction to Rock Forming Minerals, Essex: Longman Scientific and Technical; New York: Wiley., 696pp.
5. Manual of Mineralogy: Cornelius, S. Hurlbut and Cornel Klein
6. Principles of Mineralogy: W.H. Blackburn, W.H. Denman
7. Berry, L. G., Dietrich, R. V., and Mason, B., 1985, Mineralogy, CBS Publishers & Distributors, India,561p

Title of the Course and Course Code	**Practicals related to GLY 1101 and GLY 1102 - (GLY1103)**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Identify various megascopic minerals using different physical properties and various topographic features from toposheets.	
CO2	Illustrate topographic sections from a given contour map	
CO3	Classify various types of landforms on the basis of origin and characteristic features.	
CO4	Distinguish between crystal systems on the basis of elements of symmetry and forms	
CO5	Determine epicentre of earthquake from seismic data	
CO6	Perform drainage ordering from a given drainage map	

Sr. No.	Title of Experiment/ Practical
1	**Physical properties of minerals** Colour, form, streak, luster, cleavage, fracture, hardness and Specific gravity.
2	**Identification of following Megascopic minerals in hand specimens with the help of physical properties** **Silica Group:** Quartz, Rock crystal, Amethyst, Chalcedony, Agate, Jasper, Flint, **Feldspar Group:** Orthoclase, Plagioclase **Mica Group:** Biotite, Muscovite
3	**Identification of following Megascopic minerals in hand specimens with the help of physical properties** **Ca-Ba bearing minerals:** Calcite and Baryte. **Ore minerals:** Magnetite, Haematite, Chromite, Chalcopyrite, Galena, Pyrolusite, Bauxite and Graphite

	Other Group minerals: Garnet, Olivine, Amphibole- Hornblende, Alluminosilicate-Kyanite
4	**Study of elements of symmetry** Crystallographic axes and forms with indices of the **Cubic System (Type-Galena)** representing all the fundamental crystal forms.
5	Crystallographic axes and forms with indices of the **Orthorhombic System (Type- Baryte), Monoclinic System (Type- Gypsum) and Triclinic System (Type- Axinite)** representing all the fundamental crystal forms
6	Crystallographic axes and forms with indices of the **Tetragonal System (Type-Zircon) and Hexagonal System (Type- Beryl)** representing all the fundamental crystal forms **Measurement of interfacial angle with Contact Goniometer**
7	**Study of topographic maps with section drawing**
8	**Study of toposheets , Study of landforms**
9	**Stream ordering in a drainage basin** **To find the epicentre of an earthquake using seismic data**
10	**Revision Practical**

F.Y. B.Sc. Semester II		
Title of the Course and Course Code	**Palaeontology GLY1201**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe various processes involved in the formation of fossils.	
CO2	Classify various types of fossils on the basis of their morphological features.	
CO3	Examine fossils in hand specimens or under microscope.	
CO4	Explain significance of fossils in the interpretation of depositional environments.	
CO5	Compare fossils belonging to various phyla.	
CO6	Prepare a report on fossil samples collected during the study tour.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Palaeontology and Invertebrate Palaeontology** Palaeontology: Definition, branches, Importance and scope. Fossils: Definition, conditions and modes of preservation of fossils, Techniques used in collection (Spot and channel), preservation and illustration of mega fossils, Uses and Importance of fossils, Mass extinction, causes and evidence Systematic position, morphology of hard parts, geological and geographical distribution of the following: **Phylum Mollusca:** Class Lamellibranchia or Bivalvia: Morphology of hard parts of the shell, ornamentation and types of hinge lines, Class Gastropoda: Morphology of hard parts of the shell and forms of the gastropod shell, Class Cephalopoda: Morphology of hard parts of Nautilus, Ammonoids, Belemnites and type of suture lines. Comparison between Nautilus and Ammonoids. Evolutionary trends in Ammonoids Systematic position, morphology of hard parts, geological and geographical distribution of the following: **Phylum Brachiopoda** Morphology of hard parts of Class Articulata and Inarticulata. Types of brachial skeleton, Comparison between Lamellibranchs and Brachiopods. **Phylum Echinodermata** Class Echinoidea: Morphology of hard parts of Regularia. Variation in the apical disc in echinoids. **Phylum Arthropoda** Class Trilobita – Morphology of hard parts of Trilobites and evolutionary trends. **Phylum Coelenterata** Class Anthozoa- Madreporaria, polyp, medusa, types of septa. Origin and evolution of life over geological time. Concepts of organic evolution. (Definition, Evidence of evolution, Macro & Micro evolution, Darwinism, Lamarckism & Mutation)	18
II	**Micropalaeontology, Palaeobotany and Ichnology** **Micropalaeontology** Introduction to Micropalaeontology, Definition, different types of microfossils, their size range and composition Different branches of Micropalaeontology, uses of microfossils Field and Laboratory Techniques Field techniques for collection of microfossils (sampling methods), Laboratory techniques for separation- Mechanical and chemicals methods, Recovery of microfossils from shale and limestone. Separation of microfossils from coal	18

	(maceration), Preservation and Illustration. Study of the following microfossils: (with respect to their morphology, environmental and paleo-ecological significance) Foraminifers, Ostracods, Diatoms and Radiolarian **Palaeobotany** Introduction to Palaeobotany, Classification of Plants, preservation of parts of plants, Study of Pollens and Spores **C) Ichnology** Ichnofossils its classification, significance	

References:

1. Woods, H., 1958, Text Book of Palaeontology (Invertebrate), Cambridge University Press, UK.
2. Clarkston E.N.K., 1998, Invertebrate Palaeontology and Evolution, 4th Edition, Wiley – Blackwell, 468p.
3. Brasier, M.D., 2011, Microfossils, Chapman & Hall, 193p.
4. Remer: Vertebrate Palaeontology.

Title of the Course and Course Code	**Petrology GLY1202**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe various rock properties in hand specimens.	
CO2	Compare various rocks based on mineral composition and textures.	
CO3	Examine rocks in hand specimens.	
CO4	Explain formation processes of different types of rocks ,different primary and secondary structures.	
CO5	Compare rocks on the basis of different characters like mineral composition, textures, structures, depth of formation, colour etc.	
CO6	Compose a report about rock samples collected individually during the study tour.	

Unit No.	**Title of Unit and Contents**	**No. of Lectures**
I	**INTRODUCTION TO PETROLOGY AND IGNEOUS PETROLOGY** **Introduction to Petrology** Definition of petrology, lithology, petrography, petrogenesis, Major divisions and diagnostic characteristic of rocks: igneous, sedimentary and metamorphic, Rock cycle. **Igneous Petrology** Magma, its composition, physico-chemical constitution	18

	of magma, Bowen's reaction series and formation of crystals and glass, Forms of Igneous bodies: **Intrusive**-Concordant-sill, Discordant-dyke and bathoilith; **Extrusive**-Lava flows **Textures and Structures** Textures: Definition and factors controlling following textures: granitic, porphyritic, poikilitic, directive, glassy Structures: Vesicular, amygdaloidal, blocky, pillow, flow, columnar, Classification of igneous rocks, basis of Classification: Depth of formation, silica percentage, type of feldspar content and colour index, Tabular classification. Study of following rocks-dunite, granite, gabbro, syenite, diorite, pegmatite, dolerite, rhyolite, basalt, trachyte, andesite	
II	**SEDIMENTARY AND METAMORPHIC PETROLOGY** **Sedimentary Petrology** Sediments and derivation of sediments: source of sediments, mineral composition of clastic/detrital sediments, concept of matrix and cement Transportation of sediments- modes of transportation and progressive changes in sediments during transport Sedimentary environments and formation of sedimentary rocks Textures and structures Textures- Clastic and non-clastic textures, Primary sedimentary structures- lamination, bedding, cross bedding, graded bedding, ripple marks and mud cracks. Classification of sedimentary rocks and study of following rocks- laterite, bauxite, conglomerate, breccia, varieties of sandstone, shales, chemical and organic deposits **Metamorphic Petrology** Definition of metamorphism, agents of metamorphism, kinds of metamorphism Metamorphic minerals- Stress and antistress minerals Metamorphism and metamorphic products- Cataclastic- crush breccias, crush conglomerate, mylonite Thermal metamporphism- quartzite, marble, Regional metamorphism- slate, phyllite, schist and gneiss, Structures in metamorphic rocks: maculose, slaty cleavage, granulose, schistose, gneissose Tabular classification of metamorphic rocks.	18

References:

1. Principles of Petrology: Tyrrell
2. Igneous, metamorphic and sedimentary Rocks: Elher and Blatt

Title of the Course and Course Code	Practicals related to GLY 1201 and GLY 1202 - (GLY1203)	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Identify different mega fossils on the basis of morphological characters.	
CO2	Classify various ichnofossils and microfossils on the basis of morphology.	
CO3	Examine different rocks in hand specimens.	
CO4	Distinguish different optical properties in minerals under microscope.	
CO5	Determine different minerals in microsections.	
CO6	Write a report on different rocks, minerals and topographic features observed during the study tour.	

Sr. No.	Title of Experiment/ Practical
1	**Optical properties of minerals:** Study of optical properties of minerals in plane polarised light and between crossed nicols
2	**Microscopic study of rock forming minerals (Properties in PPL)** Augite, hornblende, microcline, plagioclase, biotite, calcite and garnet.
3	**Properties in BCN**
4	**Identification of the following megascopic igneous rocks with respect to their texture/structure, mineral composition and classification** Granite, gabbro, rhyolite, basalt (its varieties), pegmatite (Classification based on colour index, mineral composition and texture)
5	**Identification of the following megascopic sedimentary rocks with respect to their texture/structure, mineral composition and classification** Laterite, bauxite, breccia, conglomerate, sandstone, shale, mudstone and limestone.
6	**Identification of the following megascopic metamorphic rocks with respect to their texture/structure, mineral composition and classification** Slate, marble, quartzite, mica schist, hornblende schist, mica gneiss and hornblende gneiss.
8	**Study of specimens from Phylum MoIlusca –** Class Lamellibranchia, Class Gastropoda, Class – Cephalopoda
9	**Study of specimens from** Phylum Brachiopoda. Phylum Echinodermata, Phylum Arthropoda, Phylum Coelenterata.
10	**Micropalaeontology- Study of microfossils-** Two each from Foraminifera, Ostracoda, Pollens/ spores.
11	**Study of ichnofossils**
12	**Revision**