



Deccan Education Society's
FERGUSSON COLLEGE (AUTONOMOUS), PUNE

Learning Outcomes-Based Curriculum
for 3/4 years B. Sc. / B. Sc. (Honours) Programme
as per guidelines of
NEP-2020

for

S. Y. B. Sc. (Geology)

With effect from Academic Year

2024-2025

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 dependently and 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.

Fergusson College (Autonomous), Pune
Second Year Curriculum as per NEP 2020
Department of Geology
Structure for Major / Minor

Semester	Paper	Paper Code	Paper Title	Type	Credits
III	Major	GLY-201	Structural Geology & Tectonics	Theory	4
		GLY-200	Geology Practical-3	Practical	2
	Minor	GLY-211	Rocks and Minerals of the World	Theory	2
		GLY-212	Geology Practical-3	Theory	2
	OE	GLY-220	Weather and Climate Change	Theory	2
	VSC	GLY-230	Geogenic Disasters and Their Management	Theory	2
	SEC	GLY-240	Study of Maps	Theory	2
	CEP	GLY-245	Community Engagement Program		2
IV	Major	GLY-251	Principles of Stratigraphy and Palaeontology	Theory	4
		GLY-250	Practical-4	Practical	2
	Minor	GLY-261	Rocks Structures and Stratigraphy	Theory	2
		GLY-262	Minor Practical-4	Practical	2
	OE	GLY-270	World of Fossils	Theory	2
	VSC	GLY-280	Techniques in Sedimentology	Theory	2
	SEC	GLY-290	Gemmology	Theory	2

**OE – Open Elective, SEC- Skill Enhancement Course, VSC- Vocational Skill Course, CEP- Community Engagement Program, FP- Field Project*

Teaching and Evaluation (Only for FORMAL education courses)

Course Credits	No. of Hours per Semester Theory/Practical	No. of Hours per Week Theory/Practical	Maximum Marks	CE 40 %	ESE 60%
1	15 / 30	1 / 2	25	10	15
2	30 / 60	2 / 4	50	20	30
3	45 / 90	3 / 6	75	30	45
4	60 / 120	4 / 8	100	40	60

Eligibility: As per the rules and regulations of Savitribai Phule Pune University (SPPU)

S. Y. B. Sc. Semester-III

GLY-201	Structural Geology & Tectonics (Major-Theory)	Credits:04 Hours:60
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	State various types of forces involved in deformation of rocks, describe attitude of structures and the interior of the earth along with their physical and chemical properties.	1
CO2	Distinguish types of deformational structures and explain Earth's magnetic field and the theory of plate tectonics.	2
CO3	Analyze the processes involved in plate movements and formation of deformational structures.	3
CO4	Classify deformational structures based on their characteristics features and the characteristic features of tectonic plates.	4
CO5	Evaluate the processes involved in formation of deformational structures and the nature of boundaries of tectonic plates.	5
CO6	Prepare a report of structural data collected during field work and reconstruct plate movements.	6

Unit No.	Title of Unit and Contents	Number of Hours
I	A) Introduction to Structural Geology <ul style="list-style-type: none"> ➤ Introduction- Definition and its relation with other branches of geology, Scale of tectonic structures (Micro, Meso, Macro Regional) ➤ Introduction to concepts of Force, Stress, Strain and types of deformations (Brittle, Elastic, plastic, ductile) ➤ Planar/Linear Structures- Attitude of planar feature- Strike and Dip, Attitude of Linear Feature, Bearing, Plunge and Rake of Lination and linear structures. ➤ Determination of Top of Beds with The Help of Primary Structures (Sedimentary & Igneous) ➤ Unconformities: Definition and types 	15
II	B) Deformation Structures <ul style="list-style-type: none"> ➤ Definition, Elements, Types and Nature of – Joints, Fractures, Shear zones, Faults and Folds 	15

<p>III</p>	<p>C) Interior of the earth</p> <ul style="list-style-type: none"> ➤ Evolution and Structure of Lithosphere, Asthenosphere, Core etc. ➤ Lithosphere – Asthenosphere Interactions ➤ Concept of Isostasy ➤ Earth’s Magnetic field and its application ➤ Historical background of the plate tectonics theory 	<p>15</p>
<p>IV</p>	<p>D) Plate tectonics</p> <ul style="list-style-type: none"> ➤ Characteristics of lithospheric plates, Concept of plate margin and plate boundary. ➤ Types of plate boundaries - (Divergent, Convergent & Transform fault -description & examples) ➤ Present motion of world’s large plates. ➤ Concept of triple junctions with their examples. ➤ Concept of plate tectonics. 	<p>15</p>
	<p>References:</p> <ol style="list-style-type: none"> 1. Jain, A.K., (2014) An introduction to structural geology. Textbook series in Geological Sciences for Graduate Students, Geological Society of India, Bangalore 2. Billings, M.P., (1972) Structural Geology. Prentice Hall 3. Davis, G.R., (1984) Structural Geology of Rocks and Region. John Wiley 4. Patwardhan, A.M. (2012) The dynamic Earth System, PHI Learning Pvt. Ltd., 5. Moores E.M. and Twiss R.J. (1995) Tectonics, W. H. Freeman 6. Condie, K.C. (1989) Plate Tectonics &Crustal Evolution, Butterworth-Heinemann 7. Badgley, P. C. (1965) Structural & Tectonic Principles, Harper &Row 8. Valdiya K.S. (2014) Making of India, Springer. 9. Helmut G.F. Winkler (1967, 1986), Petrogenesis of metamorphic rocks, springer verlag 	

S. Y. B. Sc. Semester-III

S. Y. B. Sc. Semester-III		
GLY-200	Geology Practical - 3 (Major -Practical)	Credits: 02 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Identify different tectonic boundaries on world map.	1
CO2	Describe the geology from the geological map.	2
CO3	Calculate attitude of beds from given structural data.	3
CO4	Analyze geological maps with a series of horizontal beds and inclined beds.	4
CO5	Measure attitude and thickness of beds from geological maps.	5
CO6	Construct litho sections and biostratigraphic charts from given data.	6

Expt. No.	Title of Experiment
1	Structural Problems I- involving hill slope (hill slope given/ hill slope to be determined), true dip, true thickness, true width of outcrop and vertical thickness of the bed.
2	Structural Problems II- involving true and apparent Dip, true and apparent thickness, true and apparent width of outcrop and vertical thickness of the bed (True dip & true thickness/ Vertical thickness/ width of the outcrop given).
3	Structural Problems III- involving true and apparent dip of the bed- i) True dip of the bed given- To find out apparent dip amount in the given apparent dip direction ii) True dip of the bed given- To determine apparent dip direction for given apparent dip amount. iii) Two apparent dip amounts in two different directions given- To find out strike direction, true dip direction and true dip amount. Note- (Problems II and III to be solved by using descriptive geometry method involving construction of vertical section in desired directions)
4	Study of tectonic plates, plate boundaries, hot spots and triple junctions on the world map.
5	Study of geological maps with a series of horizontal beds
6	Study of geological maps with a conformable series.
7	Study of geological maps with a conformable series.
8	Study of geological maps with a conformable series with one vertical dyke.
9	Study of geological maps with a conformable series with one vertical dyke.
10	Study of geological maps with a conformable series with one or two vertical faults.
11	Study of geological maps with a conformable series with one or two vertical faults.
12	Revision

S. Y. B. Sc. Semester-III		
GLY-211	Rocks and Minerals of the World (Minor-Theory)	Credits:02 Hours:30
Course Outcomes (Cos) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe various physical properties, optical properties, crystal parameters in minerals and uses of rocks.	1
CO2	Compare various crystals based on symmetry, symmetry functions and explain crystal systems, mineral groups and rocks based on physical and optical properties.	2
CO3	Apply the understanding of physical, optical and other properties to determine the different groups and crystal systems and types of rocks.	3
CO4	Explain industrial applications and economic importance of various minerals and rocks.	4
CO5	Compare minerals and rocks on the basis of the different properties and estimate a few physical properties like hardness and specific gravity of minerals.	5
CO6	Prepare a report about rock and mineral samples in the field	6

Unit No.	Title of Unit and Contents	No. of Hours
I	<p>MINERALOGY</p> <p>A] Physical properties of minerals:</p> <ul style="list-style-type: none"> ➤ Colour, streak, lustre, cleavage and partings, fracture, form, hardness and specific gravity ➤ Properties based on magnetism, electrical properties, and radioactivity, Luminescence (Phosphorescence and Fluorescence) <p>B] Optical mineralogy:</p> <ul style="list-style-type: none"> ➤ 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, Opaque and Non opaque Minerals, Introduction to optical properties: – In plane polarized light and in between crossed nicols <p>C] Crystallography:</p> <ul style="list-style-type: none"> ➤ Definition and conditions conducive for the formation of crystals. 	15

	<ul style="list-style-type: none"> ➤ 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: Baryte), Tetragonal (Type: Zircon), Cubic (Type: Galena), Hexagonal (Type: Beryl), Monoclinic (Type: Gypsum), Triclinic (Type: Axinite) 	
II	<p>SALIENT FEATURES OF PETROLOGY</p> <ul style="list-style-type: none"> ➤ Diagnostic characters of igneous, sedimentary and metamorphic rocks. Uses of rocks and minerals in: <ul style="list-style-type: none"> • Metals • Gemstones • Ceramic • Refractory • Paint • Glass • Cement • Fertilizer • Electricals and electronics • Oil industry • Pharmaceuticals ➤ Engineering aspects of rocks ➤ Geo stone and monuments 	15

References:

1. Dexter Perkins (1998) Mineralogy. 3rd Edition, Pearson Education
2. Dana, E. S., and Ford, W. E. (1922) Text Book of Mineralogy, John Wiley, New York
3. Deer, W. A., Howie, R. A. and Zussman, J. (2013) An Introduction to Rock Forming Minerals, Essex: Longman Scientific and Technical; New York: Wiley
4. G.B. Mahapatra (2019) A Textbook of Geology, CBS Publishers & Distributors
5. Tyrrell, G.W. (2022) The Principles of Petrology: An Introduction to the Science of Rocks, 2nd Ed., AITBS Publisher
6. Kevin Hefferan and John O'Brien (2010) Earth Materials, John Wiley & Sons Publication

S. M. Sengupta (2018) Introduction to Sedimentology, 2nd Edition, CBS Publishers

S. Y. B. Sc. Semester-III

GLY-212	Geology Practical-3 (Minor-Practical)	Credits:02 Hours:30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define the elements of symmetry	1
CO2	Distinguish between crystal systems on the basis of elements of symmetry and forms	2
CO3	Classify the rocks	3
CO4	Examine different rocks in hand specimens.	4
CO5	Compare different sedimentary rocks under microscope.	5
CO6	Justify the significance of rocks from the mineral composition and texture.	6

Expt. No.	Title of Experiment
1	Study of elements of symmetry
2	Study of crystal system: Orthorhombic Type- Baryte
3	Study of crystal systems: Monoclinic: Type- Gypsum, Triclinic: Type- Axinite
4	Study of crystal systems: Tetragonal: Type- Zircon, Hexagonal: Type –Beryl
5	Study of crystal systems: Cubic: Type- Galena and study of twin crystals
6	Study of various gemstones and their properties
7	Study of igneous textures under microscope and in hand specimens
8	Study of megascopic and microscopic igneous rocks
9	Study of megascopic and microscopic sedimentary rocks
10	Study of sedimentary structures and their significance
11	Study of megascopic and microscopic metamorphic rocks
12	Revision

S. Y. B. Sc. Semester-III		
GLY-220	Weather and Climate Change (OE-Theory)	Credits:02 Hours:30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define structure of atmosphere and oceans.	1
CO2	Discuss basic concepts related to oceanic and atmospheric circulation.	2
CO3	Illustrate the use of instruments for weather data collection.	3
CO4	Analyze the types of clouds and oceanic floor features.	4
CO5	Review greenhouse effect, climate change and related concepts.	5
CO6	Compile different types of climate change related data.	6

Unit No.	Title of Unit and Contents	No. of Hours
I	Introduction to Oceans and Atmosphere <ul style="list-style-type: none"> ➤ Hypsography of ocean floor ➤ Physical and chemical properties of sea water ➤ Introduction to thermohaline circulation and ocean currents and marine economic deposits ➤ Structure of atmosphere ➤ Types of winds and global wind circulation ➤ Insolation and heat budget of the Earth 	15
II	Weather and climate <ul style="list-style-type: none"> ➤ Difference between weather and climate ➤ Measurement of weather parameters ➤ Seasons ➤ Cloud formation and types of clouds ➤ Monsoon and distribution of precipitation over India and overview of palaeomonsoon ➤ Greenhouse effect and global warming: past, present and future ➤ Climate change 	15
	References: <ol style="list-style-type: none"> 1. Alan Trujillo and Harold Thurman, (2019) Essentials of Oceanography, Pearson Publication 2. Wallace, J. M. and Hobbs, P. V. (2006) Atmospheric Sciences: An introductory Survey, Elsevier Science 	

S. Y. B. Sc. Semester-III		
GLY-230	Geogenic Disasters and Their Management (VSC-Theory)	Credits:02 Hours:30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall the concept of Environmental Geology and Geogenic disaster.	1
CO2	Discuss the various types of pollution.	2
CO3	Analyse the various environmental issues by taking remedial measures.	3
CO4	Explain the concept of Environmental Impact Assessment.	4
CO5	Classify the geogenic disaster and evaluate Geogenic disaster prone area.	5
CO6	Prepare a report on any geogenic disaster prone area.	6

Unit No.	Title of Unit and Contents	No. of Hours
I	Environmental Geology A) Scope, Concepts and Objectives of Environmental Geology B) Physical, Biological and Socio-geological Environment, Bio-geochemical cycles. C) Types of Pollution: Air, Water and Soil Pollution D) Conservation of Natural Resources E) Solid Waste Management: Generation, Collection, Segregation, Characterization, Disposal, Recycling and Reuse, Its effect with geological perspective.	15
II	Geogenic disasters and hazards A) Definition, type, natural hazards zones, distinction between hazard and disaster B) Impact assessment, Natural hazard zonation maps C) Role of Geologist in disaster management plan D) Geogenic hazards: Earthquake, Volcanoes, Cyclones, Floods, Mass movements, Mining Hazards, Coastal Hazards (Tsunami) E) Environmental Impact Assessment—Introduction and Methodology F) Urban Geology	15

References:

1. Valdiya, K.S., (1987) Environmental Geology-India. Context. Tata McGraw Hill New Delhi.
2. Keller, E.A. (2000) Environmental Geology. Shales E. Merrill Publishing Co., Columbus, Ohio.
3. Montgomery, C., (1984) Environmental Geology. John Wiley and Sons, London.
4. Bird, Eric, (2000) Coastal Geomorphology: An Introduction. John Wiley & Sons, Ltd. Singapore.
5. Liu, B.C., (1981) Earthquake Risk and Damage, Westview.
6. Sharma J. P., Environmental Studies, Laxmi Publications(P) Ltd, New Delhi UGC Document on LOCF Geology 42
7. Urban Geology: Geology & cities.
8. Environmental Impact Assessment by Raman, Gajbhiye and Khandeshwar (2019)

S. Y. B. Sc. Semester-III

GLY-240	Study of Maps (SEC-Theory)	Credits:02 Hours:30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Name the different elements of the maps	1
CO2	Compare the different survey instruments	2
CO3	Interpret different types of maps	3
CO4	Infer the contour patterns of various topographic features	4
CO5	Decide a survey method and instruments to be used for map preparation	5
CO6	Create a map using survey method and instruments	6

Unit No.	Title of Unit and Contents	No. of Hours
I	<p>Introduction to Surveying and mapping</p> <p>Maps-</p> <ul style="list-style-type: none"> ➤ History of map making, Types and uses of maps, Elements of map reading. ➤ Interpretation of topographical maps: Significance of map, Index system, Grid reference, Map reading Component of topographical map- scale, direction, symbols, coordinates, direction, distance Identification of land forms. Interpretation of land use, drainage and settlements pattern <p>Surveying:</p> <ul style="list-style-type: none"> ➤ Definitions and Overview, Role and importance of surveying, Types of surveys ➤ Components and Common terms used in various survey instruments like Dumpy level, Theodolite etc. 	15
II	<ul style="list-style-type: none"> ➤ Preparation of base map by various survey methods like plane table survey, compass survey. ➤ Interpretation of different maps using the components of maps like contour pattern, vegetation, land forms, land use land cover pattern, geology, drainage pattern etc. 	15

References:

1. Monkhouse, F.J. & Wilkinson, F.J. (1985) Maps and Diagrams. Methues, London
2. Raisz, E (1962) General Cartography. John Wiley & Sons, New York.
3. Sharma, J.P. (2001) Prayogik Bhoogol. Rastogi Pub, Meerut.
4. Singh R.L. & Singh, Rana P B (1993) Elements of Practical Geography (Hindi & English editions), Kalyani Publishers, New Delhi.
5. Singh, LR (2006) Fundamentals of Practical Geography. Sharda Pustak Bhawan, Allahabad.
6. Kanetkar, T.P. and Kulkarni, S.V. (2010): Surveying and Leveling Vol. II, Pune Vidyarthi Publication, Pune.
7. Maslov, AV., Gordeev, A.V. and Batrakov, Yu.G. (1984): Geodetic surveying, Mir Publishers, Moscow.
8. Rangwala, S.C. (2011): Surveying and Leveling, Charotar Publishing House Pvt. Ltd. Anand, (Gujarat), India
9. Punmia B.C., Jain A. and Jain A. (2011): Surveying, Vol. II. and III, Laxmi Publication - New Delhi
10. Survey of India (2009): Handbook of Topography, Chapter XI, Geographical Maps, Published by the order of Surveyor General of India

S. Y. B. Sc. Semester-III

GLY-245	Community Engagement Program (CEP)	Credits:02 Hours:30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1		1
CO2		2
CO3		3
CO4		4
CO5		5
CO6		6

Unit No.	Title of Unit and Contents	No. of Hours
I		15
II		15
	References:	

S. Y. B. Sc. Semester-IV

GLY-251	Principles of Stratigraphy and Palaeontology (Major-Theory)	Credits:04 Hours:60
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe various processes involved in the formation of fossils and the concept, various elements of stratigraphy.	1
CO2	Explain the various types of fossils on the basis of their morphological features and processes of stratification.	2
CO3	Examine fossils in hand specimens or under microscope and special temporal distribution.	3
CO4	Classify the microfossils and stratigraphic units	4
CO5	Compare fossils belonging to various phyla and stratigraphic procedures	5
CO6	Prepare a report on stratigraphic data and fossil samples collected during the study tour.	6

Unit No.	Title of Unit and Contents	Number of Hours
I	<p>Principles of Stratigraphy and Stratification:</p> <p>A) Introduction: Definition, Development of stratigraphic concepts, Importance of Stratigraphy, Various principles of Stratigraphy</p> <p>B) Stratigraphic Classification & Nomenclature: Study of stratigraphic elements, Lithostratigraphy, Chronostratigraphy, Biostratigraphy, Inter-relationship between lithostratigraphic, Chronostratigraphic and Bio stratigraphic units. Introduction to Magnetostratigraphy, Sequence Stratigraphy</p> <p>C) Methods of Collecting Stratigraphic Data: Outcrop and Sub surface procedures.</p> <p>D) Stratification: Introduction to concept of basin, Processes of stratification, Controlling factors-physical, chemical and biological, Vertical succession, alternations, varves, cycles. Stratigraphic Correlation: Definition and evidence for correlation- physical and palaeontological</p>	15
II	<p>Palaeontology:</p> <p>A) Introduction to Palaeontology and Invertebrate Palaeontology</p> <p>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, Systematic position, morphology of hard parts, geological and geographical distribution of the following:</p> <p>Phylum Mollusca: Class Lamellibranchia or Bivalvia: Morphology of hard parts of the</p>	15

	<p>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.</p>	
III	<p>B) Systematic position, morphology of hard parts, geological and geographical distribution of the following:</p> <p>Phylum Brachiopoda: Morphology of hard parts of Class Articulata and Inarticulata. Types of brachial skeleton, Comparison between Lamellibranchs and Brachiopods.</p> <p>Phylum Echinodermata: Class Echinoidea: Morphology of hard parts of Regularia & irregular. Variation in the apical disc in echinoids.</p> <p>Phylum Arthropoda: Class Trilobita – Morphology of hard parts of Trilobites and evolutionary trends.</p> <p>Phylum Coelenterata: Class Anthozoa- Madreporaria, polyp, medusa, types of septa. Origin and evolution of life over geological time. Mass extinction, causes and evidence Concepts of organic evolution. (Definition, Evidence of evolution, Macro & Micro evolution, Darwinism, Lamarckism & Mutation).</p>	15
IV	<p>C) Fossils in different depositional environments:</p> <p>Introduction to Micropalaeontology, Definition, types of microfossils, their size range and composition Different branches of Micropalaeontology, uses of microfossils</p> <p>Field and Laboratory Techniques, Field techniques for collection of microfossils (sampling methods), Laboratory techniques for separation- Mechanical and chemical methods, Recovery of microfossils from shale and limestone. Separation of microfossils from coal (maceration), Preservation and Illustration.</p> <p>Study of the following microfossils: (with respect to their morphology, environmental and paleo-ecological significance) Foraminifers, Ostracods, Diatoms and Radiolarian</p> <p>Palaeobotany: Introduction to Palaeobotany, Classification of Plants, preservation of parts of plants, Study of Pollens and Spores</p> <p>Ichnology: Ichnofossils its classification, significance</p>	15
	<p>References:</p> <ol style="list-style-type: none"> 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. 	

	<ol style="list-style-type: none">5. Text- book of Palaeontology, (2022-23) Paperback,P C Jain and M. S. Anatharaman6. Krumben and Sloss (1963) Stratigraphy and Sedimentation, W.H.Freeman7. Friedman & Sanders, (1978) Principles of Sedimentology. John Wiley andsons.8. IUGS Stratigraphic nomenclature9. GSI stratigraphic nomenclature	
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S. Y. B. Sc. Semester-IV

GLY-250	Practical-4 (Major-Practical)	Credits: 02 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Identify different mega fossils on the basis of morphological characters	1
CO2	Classify various Ichnofossils and microfossils on the basis of morphology	2
CO3	Interpret the date lithological data.	3
CO4	Examine the microfossils	4
CO5	Measure attitude and thickness of beds from geological maps.	5
CO6	Write a report on different rocks and structural features observed during the study tour.	6

Expt. No.	Title of Experiment
1	Construction of litholog from the given data.
2	Construction of various biostratigraphic charts from the given data
3	Identification of geological features by correlating the lithologs.
4	Interpretation of stratigraphic principles from maps
5	Interpretation of stratigraphic principles from maps with two conformable series.
6	Interpretation of stratigraphic principles from maps with one or two conformable series and vertical dyke or fault.
7	Study of specimens from Phylum Mollusca: Class Lamellibranchia, Class Gastropoda, Class Cephalopoda
8	Study of specimens from Phylum Brachiopoda, Phylum Echinodermata, Phylum Arthropoda, Phylum Coelenterata
9	Micropalaeontology- Study of microfossils- Two each from Foraminifera, Ostracoda, Pollens/ spores
10	Study of Ichnofossils
11	Field work
12	Revision

S. Y. B. Sc. Semester-IV

S. Y. B. Sc. Semester-IV		
GLY-261	Rocks Structures and Stratigraphy (Minor-Theory)	Credits:02 Hours:30
Course Outcomes (Cos) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe forces involved in deformation of rocks, attitude of structures.	1
CO2	Explain types of deformational structures.	2
CO3	Illustrate deformational structures produced by various deformational.	3
CO4	Classify stratigraphic units.	4
CO5	Evaluate the processes of stratification.	5
CO6	Prepare a report of stratigraphic data.	6

Unit No.	Title of Unit and Contents	No. of Hours
I	<p>Introduction to Structural Geology</p> <ul style="list-style-type: none"> ➤ Introduction: Definition and its relation with other branches of geology, Scale of tectonic structures (Micro, Meso, Macro Regional) ➤ Deformation: Introduction to concepts of Force, Stress, Strain and types of deformations (Brittle, Elastic, plastic, ductile) ➤ Planar/Linear Structures: Attitude of planar feature- Strike and Dip, Attitude of Linear Feature, Bearing, Plunge and Rake of Lineation and linear structures. ➤ Unconformities: Definition, types and its significance ➤ Deformational Structures: Definition, Elements, Types and Nature of – Joints, Fractures, Shear zones, Faults and Folds 	15

<p style="text-align: center;">II</p>	<p>Principles of Stratigraphy and Stratification</p> <ul style="list-style-type: none"> ➤ Introduction: Definition, Development of stratigraphic concepts, Importance of Stratigraphy, Various principles of Stratigraphy ➤ Stratigraphic Classification & Nomenclature: Study of stratigraphic elements, Lithostratigraphy, Chronostratigraphy, Biostratigraphy, Inter-relationship between lithostratigraphic, Chronostratigraphic and Bio stratigraphic units. ➤ Methods of Collecting Stratigraphic Data: Outcrop and Sub surface procedures. ➤ Stratification: Introduction to concept of basin, Processes of stratification, Controlling factors-physical, chemical and biological, Vertical succession, alternations, varves, cycles. ➤ Stratigraphic Correlation: Definition and evidence for correlation- physical and palaeontological 	<p style="text-align: center;">15</p>
	<p>References:</p> <ol style="list-style-type: none"> 1. Jain, A.K., (2014) An introduction to structural geology. Textbook series in Geological Sciences for Graduate Students, Geological Society of India, Bangalore 2. Billings, M.P., (1972) Structural Geology. Prentice Hall 3. Davis, G.R., (1984) Structural Geology of Rocks and Region. John Wiley 4. Krumben and Sloss (1963) Stratigraphy and Sedimentation, W.H. Freeman 5. Friedman & Sanders, (1978) Principles of Sedimentology. John Wiley and sons. 6. IUGS Stratigraphic nomenclature 7. GSI stratigraphic nomenclature 	

S. Y. B. Sc. Semester-IV

GLY-262	Practical-4 (Minor-Practical)	Credits:02 Hours:30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Identify the strike and dip direction from the given structural data	1
CO2	Describe the geology from the geological map.	2
CO3	Calculate attitude of beds from given structural data.	3
CO4	Analyze geological maps with a series of horizontal beds and inclined beds	4
CO5	Measure attitude and thickness of beds from geological maps.	5
CO6	Construct litho sections and biostratigraphic charts from given data	6

Expt. No.	Title of Experiment
1	Construction of litholog from the given data.
2	Construction of various biostratigraphic charts from the given data
3	Identification of geological features by correlating the lithologs.
4	Study of geological maps with a series of horizontal beds.
5	Study of geological maps with a conformable series.
6	Study of geological maps with a conformable series.
7	Study of geological maps with a conformable series with one vertical dyke.
8	Study of geological maps with two conformable series.
9	Study of geological maps with two conformable series.
10	Study of geological maps with a conformable series with one vertical fault.
11	Structural Problems I- involving hill slope (hill slope given/ hill slope to be determined), true dip, true thickness, true width of outcrop and vertical thickness of the bed.
12	Revision

S. Y. B. Sc. Semester-IV		
GLY-270	World of Fossils (OE-Theory)	Credits:02 Hours:30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe various processes involved in the formation of fossils.	1
CO2	Explain significance of fossils in the interpretation of depositional environments.	2
CO3	Examine fossils in hand specimens or under microscope.	3
CO4	Classify various types of fossils on the basis of their morphological features.	4
CO5	Compare fossils belonging to various phyla.	5
CO6	Prepare a report on fossil samples collected during the study tour.	6

Unit No.	Title of Unit and Contents	No. of Hours
I	<p>A. Introduction to Palaeontology</p> <p>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.</p> <p>Origin and evolution of life over geological time. Mass extinction: Causes and evidence Concepts of organic evolution. (Definition, Evidence of evolution, Macro & Micro evolution, Darwinism, Lamarckism & Mutation). Vertebrate Palaeontology: Human evolution and overview Introduction to anthropology and archaeology:</p>	15
II	<p>B) Invertebrate Palaeontology: Systematic position, morphology of hard parts, geological and geographical distribution of the following:</p> <p>Phylum Mollusca: Class Lamellibranchia or Bivalvia: Class Gastropoda: Class Cephalopoda Phylum Brachiopoda: Morphology of hard parts of Class Articulata and Inarticulata.</p>	15

	<p>Phylum Echinodermata Phylum Arthropoda: Class Trilobita Phylum Coelenterata: Class Anthozoa C) Ichnology: classification and significance</p> <p>D) Introduction to Micropalaeontology: Different branches of Micropalaeontology, uses of microfossils, Field and Laboratory Techniques</p> <p>Study of the following microfossils: (with respect to their morphology, environmental and paleo-ecological significance) Foraminifers, Ostracods, Diatoms and Radiolarian, Pollens and spores.</p>	
	<p>References:</p> <ol style="list-style-type: none"> 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. 5. Text- book of Palaeontology, (2022-23) Paperback,P C Jain and M. S. Anatharaman 	

S. Y. B. Sc. Semester-IV		
GLY-280	Techniques in Sedimentology (VSC-Theory)	Credits:02 Hours:30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe various techniques in sedimentology.	1
CO2	Discuss the systematic approach to field log preparation.	2
CO3	Interpret granulometric and paleocurrent data.	3
CO4	Analyse the given sedimentological data.	4
CO5	Evaluate the sedimentological data to determine depositional environment and source area.	5
CO6	Prepare and validate the given sedimentological data by using bivariant and multivariant plots.	6

Unit No.	Title of Unit and Contents	No. of Hours
I	Field Techniques in Sedimentology - I Systematic sampling, Field data collection and preparation of lithologs	15
II	Lab Techniques in Sedimentology – II Granulometric analysis, graphical representation and interpretation of grain size data, Provenance studies by Heavy Mineral, Modal and Geochemical analyses, graphical representation and interpretation Paleocurrent analysis, graphical representation and interpretation.	15
	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	

S. Y. B. Sc. Semester-IV		
GLY-290	Gemmology (SEC-Theory)	Credits:02 Hours:30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe the attributes of gemstones	1
CO2	Discuss the use of different gem instruments in identification of the gemstones	2
CO3	Examine the treatments used in the gemstones to enhance their attributes	3
CO4	Compare various gemstones based on their physical and optical properties.	4
CO5	Discriminate between synthetic and natural gemstones	5
CO6	Organize various gemstones into different groups based on their physical and optical properties	6

Unit No.	Title of Unit and Contents	No. of Hours
I	Introduction to Gemmology and Gem Species: <ul style="list-style-type: none"> ➤ 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	15
II	Diamonds, Gem Synthesis, Treatments and Gem Identification: <ul style="list-style-type: none"> ➤ 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	15

	References:	
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- 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
- Bruton Eric (1978) Diamonds, Chilton Book Company