Deccan Education Society's

Fergusson College (Autonomous)
Pune - 411004

Curriculum

as per guidelines of

NEP-2020

for

M. Sc. Part- I (Geology)

With effect from Academic Year

2023-2024

Program Structure of M.Sc. (Geology) Part-I

Semester	Paper Code	Paper Title	Credits
I	GLY-501	Igneous Petrology	4
	GLY-502	Metamorphic Petrology	4
	GLY-503 OR GLY-504	Geomorphology, Remote Sensing and GIS OR Natural Resource Management	4
	GLY-510	Research Methodology	4
	GLY-520	Practical - I	2
	GLY-521	Practical - II	2
		Total Semester Credits	20
II	GLY-551	Sedimentology	4
	GLY-552	Structural Geology	4
	GLY-553 OR GLY-554	Engineering Geology and Geotechniques OR Environmental Geology	4
	GLY-560	**On Job Training / Field Project**	4
	GLY-570	Practical - III	2
	GLY-571	Practical - IV	2
		Total Semester Credits	20
		Total PG-I Credits	40

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)

Program Outcomes (POs) for M. Sc. Programme	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the discipline that form a part of a postgraduate programme. Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	**Social competence:** Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise and help reach conclusion in group settings.
PO4	**Research-related skills and Scientific temper:** Infer scientific literature, build sense of enquiry and able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	**Trans-disciplinary knowledge**: Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence**: Perform independently 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.

Program Specific Outcomes (PSOs) for M. Sc. Geology	
PSO No.	**Program Specific Outcomes(PSOs)** **Upon completion of this programme the student will be able to**
PSO1	**Academic competence** **(i)** Understand fundamental concepts, principles and processes underlying the field of Geology, its different subfields and its linkage with related disciplinary areas/subjects **(ii)** Demonstrate an understanding of a wide range of geological processes (e.g. genesis of rocks and formation of geological structures, formation of minerals and their alteration, effects of human activities at meso to microscale.) **(iii)** Undertake field tour in any part of India with respect to lithology, structure and stratigraphy and produce geological maps
PSO2	**Personal and Professional Competence** **(i)** Carry out field mapping in any part of India with respect to lithology, structure and stratigraphy and produce geological maps. **(ii)** Analyse geological data and samples procured during field work. **(iii)** Formulate ideas, execute scientific writing and authentic reporting, geological maps, effective presentation and communication skills.
PSO3	**Research Competence** **(i)** Apply skills developed towards comprehension of geological conditions to address issues and find solutions in case of ground water, mineral and fossil fuel exploration and geo hazards. **(ii)** Integrate informatics and statistical skills to explore and authenticate field and laboratory data for experimental and research purpose
PSO4	**Entrepreneurial and Social Competence:** **(i)** Employ Plan and conduct various geological services with demonstration of true values of leadership, co-operation and teamwork. **(ii)** Demonstrate awareness of ethical issues: Emphasizing on academic and research ethics, scientific misconduct, intellectual property rights and issues of plagiarism.

	M. Sc. Part- I, Semester I	
Title of the Course and Course Code	**GLY -501: Igneous Petrology**	**Number of Credits : 04**
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe the distribution of various rock types in the earth's crust and mantle.	
CO2	Discuss the physical and chemical processes that produce the full range of igneous rock types.	
CO3	Classify Igneous rocks with respect to different standard classification schemes.	
CO4	Analyze various rocks on the basis of chemical characteristics and comment on their origin.	
CO5	Compare various types of igneous rocks occurring in different tectonic settings on the basis of physical and chemical characters.	
CO6	Compile information of various types of Igneous rocks occurring in India.	

Unit. No.	Content
Unit I	**Role of magma in Geological processes** Magma definition and source of magma, Anatomy of the earth Magmatism and plate tectonics, Physical properties of Magma-Geochemical gradient, Heat source, Igneous activity of the present day Textures and structures of Igneous rocks, Classification of Igneous rocks-historic perspective and the IUGS system.
Unit II	**Geochemical tracers of mantle processes** Introduction, Continental and oceanic mantle lithosphere MORB and depleted mantle, Evolution of depleted mantle OIB and Enriched mantle, Evolution of Enriched mantle – metasomatic processes Island arc basalts, Mantle Plumes-Theory and structure Concept of hot spots, Re-Os Isotope systematic Trace element characterizations of mantle domains
Unit III	**Magma Crystallization and Evolution** Phase relations of the silicates and silicate melts Binary and Ternary systems, Partial melting Magmatic differentiation – Crystal fractionation, gravitational Settling, flow differentiation, flow crystallisation, filter pressing, liquid immiscibility. Zone melting, Contamination, Mixing of magmasRole of volatile components
Unit VI	**Petrogenetic provinces** Continental areas: Volcanic- Flood basalts- Tholeiites (Deccan Trap,Columbia River basalts, Parana basalts) Layered gabbroic intrusions: The Bushveld complex, Skaergaard intrusion,Still water complex. Plutonic: Carbonatites and alkaline rock complexes of India Oceanic Rift valleys: MORB- Tholeiites-Ophiolites Granites, andesites, kimberlites, anorthosites.

Text / Reference Books:	1. Best Myron G., 1982, Igneous and Metamorphic Petrology, CBS Publishers and Distributors Pvt. Ltd. 2. Philpotts A,1990, Principles of Igneous and Metamorphic Petrology, Prentice Hall 3. Winter J D,2010, Principles of Igneous and Metamorphic Petrology, CBS Publishers and DistributorsPvt. Ltd, 2nd Edition 4. Wilson Marjorie,1987, Igneous Petrogenesis, Unwin Hyman.

Title of the Course and Course Code	**GLY -502: Metamorphic Petrology**	**Number of Credits : 04**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Describe various types of metamorphism based on controlling factors.	
CO2	Discuss the types of textures and metamorphic mineral growth relative to deformation.	
CO3	Examine metamorphic grade and Facies based on mineral assemblages, PT conditions, and bulk rock chemical composition.	
CO4	Compare regional and thermal metamorphism of different rocks.	
CO5	Determine the grade of metamorphism based on the textures and mineral assemblages.	
CO6	Construct phase diagrams to understand the relationships between mineral assemblages and plots of ACF, AKF, AFM diagrams.	

Unit. No.	**Content**
Unit I	**Concepts and Theory** Historical background Types of Metamorphism and their controlling factors Common minerals of metamorphic rocks Field observations, petrographic classification of common metamorphic rocks Metamorphic facies and facies series
Unit II	**Effects of Metamorphism** Phase diagrams and graphic representation of mineral assemblages Prograde and retrograde metamorphism, Metasomatism Deformation textures and textures related to recrystallisation Metamorphic reactions, elemental exchange and Pressure – Temperature conditions of Isograds
Unit III	**Metamorphism types and products** Regional and thermal metamorphism of pelitic rocks. Regional and thermal metamorphism of basic rocks Regional and thermal metamorphism of impure carbonate rocks and ultrabasic rocks

Unit IV	**Metamorphism in space and time** Granitoids, Charnockites, Migmatites Plate tectonics and metamorphic processes Paired metamorphic belts, Archaean and Proterozoic terrains Extraterrestrial Metamorphism (Impact and Shock Metamorphism) polymetamorphism
Text / Reference Books:	1. Best Myron G., 1982, Igneous and Metamorphic Petrology, CBS Publishers and DistributorsPvt. Ltd. 2. Miyashiro A., 1994, Metamorphism and Metamorphic Belts, Springer 3. Winter J D,2010, Principles of Igneous and Metamorphic Petrology, CBS Publishers andDistributors Pvt. Ltd, 2nd Edition 4. Yardley B.W.D.,1989, An Introduction to Metamorphic Petrology, Longman Scientific andTechnical

Title of the Course and Course Code	GLY -503: Geomorphology, Remote sensing and GIS	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe various geomorphic processes and resultant landforms.	
CO2	Discuss historical perspective and development of geomorphological concepts.	
CO3	Apply geomorphological knowledge in disaster management, town planning and hydrogeology.	
CO4	Analyze GIS and Remote Sensing data.	
CO5	Discriminate application based between various types of GIS software and Remote sensing data.	
CO6	Plan geological investigation using remote sensing data and GIS tools.	

Unit. No.	Content
Unit I	**Geomorphology I** Introduction: Development, Scope, Geomorphic concepts, Types and Tools Evolution of Landforms Endogenous and Exogenous forces, Role of Lithology, Peneplanation Rejuvenation of landforms- climatic and tectonic factors Denudational processes, Weathering, erosion and transportation Weathering products and soils profiles, types, duricrusts Hillslopes : Their characteristics and development, fluvial processes on hillslopes
nit II	**Geomorphology II** River and drainage basin: drainage pattern, network characteristics, valleys and their development, processes of river erosion, transportation and deposition Depositional and erosional landforms- Fluvial, Coastal, Glacialand Aeolian Geomorphic indicators of neotectonic movements Stream channel morphology changes, drainage modifications, fault reactivation, Uplift – subsidence pattern in coastal areas Applied Geomorphology: Application in Geohydrology, Engineering Geology and Environmental studies Geomorphology of India: Geomorphic features and zones
Unit III	**Remote Sensing** Remote Sensing – Principles and Processes Electromagnetic radiation and spectrum Interaction of EMR with the earth, Reflectance, absorption, emittance and transmittance Interaction of EMR with atmosphere, Scattering, absorption Cartography and Projection systems Remote sensing from space – Platform, Sensors and Data Products, interpretation for geological and other studies IRS – Cartosat, Resourcesat, Oceansat, SARAL, Landsat7and 8, IKONOS, Quickbrid. Thermal IR remote sensing and its applications

	Microwave remote sensing and its applications Hyper spectral remote sensing and its applications LIDAR, ALTM, SONAR -Basic principles, Types and Platforms and their applications GNSS- GPS and INSS, Principle, satellites and applications Geological Applications of Remote Sensing data and case studies
Unit IV	**Geographical Information System** GIS Technology & Applications Conceptual model of Spatial information Conceptual model of Non-spatial information Relational Model, Object orientated Database Digitization, Editing, Structuring of map data Map Projections. - Classification, Projection Type Vector based spatial Analysis Raster based spatial Analysis Digital Elevation Model and Application Applications – Case studies • Exploration of Water, Minerals and Oil • Monitoring and management of Mines • Disaster management
Text / Reference Books:	1. Kale VS, Gupta A,2005, Introduction to Geomorphology, Orient Blackswan Private Limited 2. Savindra Singh,1998, Geomorphology, CBS Publishers and Distributors Pvt. Ltd 3. Thornbury William D.,1958, Principles of Geomorphology, CBS Publishers and Distributors Pvt. Ltd 4. Gupta, R.P., 2008, Remote Sensing Geology, Springer. 5. Jensen J.R., 2014, Remote Sensing of the Environment, Pearson 6. Lillesand, T.M. and Kiefer, R.W., 1999, Remote Sensing and Image Interpretation, Sec. Ed., John Wileyand Sons, Inc. 7. Sedimentary Environments: with reference to clastics. Springer-Verlag 8. Harold Reading, 1996, Sedimentary Environments: Processes, Facies and Stratigraphy. Wiley-Blackwell 9. Anji Reddy M., Textbook of Remote Sensing and Geographical Information System, 2001, BSP BSPublication 10. Burroughts P.A., Principles of Geographical Information Systems for Land Resources Assessment, 1986,Oxford University Press Shahab Fazal, GIS Basic, 2008, New Age International)

Title of the Course and Course Code	GLY-504: Natural Resource Management	Number of Credits : 04
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Classify the natural resources.	
CO2	Discuss Polices and legislation concerning natural resources	
CO3	Describe various hazards and mitigation measures.	
CO4	Analyse the potential impact of a certain activity on Environment	
CO5	Document the changes occurring due to human activities	
CO6	Make an Energy Audit based on case study	

Unit. No.	Content
Unit I	Natural Resource Management Natural resources- soil, water, minerals, Land, Flora and Faunal Resources Classification of the Natural Resources Renewable resources-with Indian scenario (solar, wind, tidal, biofuels) Energy Resources-oil, natural gas, atomic minerals Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Wetlands-classification. Conservation & Management Coastal resources & Coastal Zone Management Function and values of the resource; Supply and demand
Unit II	Environmental Impact Analysis Polices and legislation concerning natural resources Conservation & Management of natural resources: soil, water, minerals Bio resources Energy Management Sustainability; UNEP programme towards sustainable development Geospatial technology for NRM Energy Audit and Management
Unit III	Fundamental concepts of environmental geosciences, its scope and necessity. Ecology and Ecosystems Biogeochemical cycles Geological hazards Coastal hazards Water pollution and other Issues; Case histories Groundwater pollution source
Unit IV	Soil pollution Sand Mining, Solid Waste Management, Eutrophication, Wastewater treatment Global climate change, United Nations Framework Classification Anthropogenic environmental impacts Ecotourism and other environmental services

Text / Reference Books:	1) *Shenk T.M. and A.M.Franklin*: 2001, Modeling in Natural Resource Management Development, Interpretation and Application, Island Press. 2) *Wondolleck J.M. and S.L. Yaffee*: 2000, Making Collaboration Work Lessons from Innovation in Natural Resource Management, Island Press. 3) *Paine D.P.*: 1981, Aerial Photography and Image Interpretation for Resource Management, John Wiley and Sons, New York, 571 p. 4) *Richason B.F.,Jr.*: ed. 1978, Introduction to Remote Sensing of the Environment, Kendall/ Hunt Publishing Company, Dubuque, Iowa, 496 p.

Title of the Course and Course Code	GLY-510: Research Methodology	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Understand basic of research problem.	
CO2	Perform literature review.	
CO3	Identification of research gap and research problem.	
CO4	Analysis the techniques used in the field and laboratory for geological samples	
CO5	Compare the methods of sampling, and analytical techniques	
CO6	Integrate the knowledge of the studies for paper presentation, oral presentation and report writing and publication of research paper.	

Unit. No.	Content
Unit I	Statistical analysis and its significance, Exploratory and confirmatory research, Planned and ad-hoc methods of data collection, Non-response and methods of recovering the missing response, Various software for statistical analysis. The module will consist of case studies of the research performed in various subjects using statistical methods, Error and noise analysis, curve fitting.
Unit II	Literature search, selection of research topic (case study based), maintaining laboratory records (case study based). Safety in Laboratories, Ethical considerations, effective verbal and non-verbal communication, field data collection, safety in field.
Unit III	Writing research paper and/or thesis, making a presentation, writing a research proposal, and patents in Science, technology.
Unit IV	Methods of sampling, and analytical techniques: Collection of air, water, soil and rock samples, Preparation of samples for microscopic examination and chemical analysis, Analytical Techniques viz. AAS, XRF, ICP, EPMA, Mass Spectrometry and Portable analytical techniques, Geospatial and Fundamentals of Geoscientific Writing and relevant software's, Research Ethics, Intellectual Property Rights (IPR) and Plagiarism.
Text / Reference Books:	1.Research Methodology: A Hand Book - Geological Survey of India, M. Ramakrishna. 2. Research Methodology: A Hand Book by R. P. Mishra. 3. Research Methodology in Geology by Arnold Luwang Usham. 4. Handbook of Research on Methodology and Techniques: B. K. Daniel. 5. Research Methodology by C. R. Kothari.

Title of the Course and Course Code	GLY-520: Practical - I	Number of Credits : 04
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Identify different rocks in thin sections and write petrography.	
CO2	Identify and explain various structures in Igneous rocks.	
CO3	Describe various landform using aerial photographs and satellite image.	
CO4	Prepare EIA Report.	
CO5	Analyze and interpret morphometric data of a basin.	
CO6	Assess class of the rock by solving CIPW Norms.	

Unit No.	Content
	Practical I 1. Identification of rock forming minerals under microscope 2. Study of Igneous rocks in hand specimen 3. Characterization of following rock type under microscope i. Ultrabasic rocks, Basic Igneous rocks, Intermediate Igneous rocks ii. Acid Igneous rocks, Alkaline Igneous rocks 4. CIPW normative calculations for Igneous rocks 5. Use of Geochemical analysis in Igneous Petrogenesis **Elective 1** 1. Drainage analysis- Basin characteristic factor, Stream characteristic factor, Stream order analysis and Slope analysis 2. Hypsometry, GAT indices and longitudinal profiling 3. Study of landforms and interpretation of lithology and structure from aerial photograph and satellite images 4. Scale measurement, conversion and preparation of base map from Image, Toposheet and DEM **Elective 2** 1. Introduction to the methods of Environmental Impact assessment - geological aspects 2. Assessment of Soil - Water - Energy Mineral Resources 3. Delineation of natural resources by using remote sensing techniques

Title of the Course and Course Code	GLY-521: Practical - II	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Identify metamorphic rocks in hand specimens and thin sections.	
CO2	Interpret metamorphic grade and type of metamorphism based on metamorphic textures.	
CO3	Comment on significance of atomic / radioactive mineral as a natural resource.	
CO4	Solve mesonorms, ACF and A'KF using geochemical data.	
CO5	Evaluate vector database using geoprocessing techniques.	
CO6	Generate maps using various GIS techniques.	

Unit. No.	Content
	Practical II 1. Identification of rock forming minerals under microscope 2. Study of metamorphic rocks in hand specimens 3. Study of metamorphic rocks in thin sections 4. Metamorphic mineral assemblages with respect to metamorphic facies and grades 5. Use of ACF, A'KF and AFM diagrams 6. Calculation of mesonorms **Elective 1** 1. Geo-referencing of Toposheet and Satellite Data 2. Image subsetting, Resolution merge 3. DEM generation, Unsupervised and Supervised Classification. 4. Preparation of vector database and maps, Corrections of errors in GIS database 5. Geo processing of Vector data- clip, merge, union, intersect **Elective 2** 1. Study of physical properties of Coal 2. Study of physical properties of Atomic / Radioactive Minerals

	F.Y. M.Sc. Semester II	
Title of the Course and Course Code	**GLY -551 Sedimentology**	**Number of Credits : 04**
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe the various principles of sediment transport by fluid motion.	
CO2	Classify Biogenic, Chemical and Volcanoclastic sediments and sedimentary rocks.	
CO3	Apply knowledge of tectonic settings to classify sedimentary basins.	
CO4	Analyze data regarding provenance, paleocurrents and facies.	
CO5	Compare characteristics of different depositional systems.	
CO6	Formulate sedimentary sequence based on various depositional systems and facies of a given region.	

Unit. No.	Content
Unit I	**Origin of sediments and transport** Introduction: Definition of Sedimentology, Sedimentary Petrology and Applications Definition of weathering, erosion, denudation. Types and Products of weathering, Mineral stability index Origin of sediments: siliciclastics, volcaniclastics, carbonates, chemical precipitates Sediment transport by fluid motion: Fluid properties and fluid motion: a) Physical properties of fluid b) Laminar and Turbulent flow, c) Stokes law d) Reynolds and Froude numbers Modes of sediment transport Hydrodynamic factors and Bed forms a) Concept of flow regime; b) Classification and characteristics of Flow regimes; c) Bed forms characterizing different flow regimes. d) Sedimentary Structures – their Genesis and Stratigraphic Significance. Diagenesis: Processes, Types, Clastic and carbonate digenesis Classification and Petrography of Sedimentary rocks Classification of terrigenous clastic sediments and sedimentary rocks (Breccias, Conglomerates, Sandstones, argillites). Classification of Biogenic, Chemical and Volcanogenic sediments and sedimentary rocks (Carbonates,evaporates, volcanoclastics, phosphorites, carbonaceous etc.)

Unit II	**Depositional Systems and Facies** Classification of Depositional Systems Siliciclastic Depositional environments. Carbonate Depositional Systems Chemical and Other depositional systems Facies concept Concepts of accommodation, base-levGLY, transgressions and regressions, shore-line trajectories, absolute and relative sea-levels, uplift and subsidence. Concept of Walther's Law of facies succession;
Unit III	**Basin Evolution and Basin Fills** Classification of sedimentary basins based on tectonic settings Pre-,Syn-, and Post depositional basins. Basin Morphology and Depositional Environments. Tectonics of sedimentary basins in Convergent, Divergent and shear settings Basin-Fill models of Basins in Divergent settings (Continental and Oceanic rifts, passive margins) Convergent settings (deep sea trenches, forearc and backarc basins) Pull apart basins Remnant and Foreland basins. Basin Type Transitions (polyhistory Basins)
Unit III	**Methods in Sedimentary Basin Analysis** Provenance Analysis using Clastic petrographic data Paleocurrent Analysis Facies Analysis Recognition of cycles and rhythms in sedimentary sequences Concept of Geohistory Analysis (Subsidence analysis)
Text / Reference Books:	1. Sam Boggs Jr., 2005, Principles of Sedimentology and Stratigraphy, Pearson 2. Gary Nichols, 2009, Sedimentology and Stratigraphy,Wiley-Blackwell 3. Donald R. Prothero and Fredric Schwab, 1996, Sedimentary Geology, W. H.Freeman 4. Maurice E. Tucker,1982 Sedimentary Rocks in the field: A pratical guide,Wiley-Blackwell **5.** Andrew D. Miall , 1984, Principles of Sedimentary Basin Analysis,Springer **6.** Gerhard Einsele, 1992, Sedimentary Basins: Evolution, Facies and sediment budget,Springer- Verlag

Title of the Course and Course Code	GLY 552: Structural Geology	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe behavior of rocks under different stress and strain regimes.	
CO2	Explain geodynamism of Earth system.	
CO3	Examine and formulate appropriate methods for deformation analysis.	
CO4	Classify the structures on the basis of different parameters.	
CO5	Compare between micro, meso and macro structures.	
CO6	Construct Mohr circle using stress-strain data.	

Unit. No.	Content
Unit I	**Rock Deformation** Theories of rock failure; Mechanical principles, properties of rocks and their controlling factors; Concept of stress and strain: Types of stress; stress ellipsoid; strain ellipsoid, Stress-strain relationship; Strain parameters Mohr circle construction; 2 D and 3 D Progressive deformation, significance of geological structures in relation to strain, pore pressure, failure of rocks due to differential stress Coaxial and non-coaxial deformation Mechanism of rock fracturing
Unit II	**Deformation structures** Fractures and joints: classification, nomenclature, relationships and significance; Joints/fractures in relation to stresses and their geometrical relationship with folds and faults. Faults: Causes, mechanism and dynamics of faulting, strike-slip faults, normal faults, reverse faulting Shear Zones: Brittle and ductile shear zones, geometry and products of shear zones; Mylonites and cataclasites: their origin and significance. Folds; Geometric and genetic classification, Superimposed folding, structures associated and significance Unconformity and Basement Cover relationship
Unit III	**Structural Analysis** Scope of structural analysis, MACRO-MESO- MICRO. Concept of Tectonites and their types. Planar and Linear structures, classification, origin, systematic mapping in field using standard terminology, measurement and recognition of domains, eigen value. Plotting of linear and planar structures, π and β diagrams; significance in regional studies

Unit IV	**Deformation and Metamorphism** Introduction, basic principles of deformation mechanism, concept of microtectonics. Behavior of important minerals. Porphyroblasts: origin and relationship with planar structures, S_i and S_e. Dilation sites- Veins, Strain Shadows, Fringes and Boudins, origin and significance. Microscopic Shear sense indicators, integrating information with MESO and MACRO. Special Techniques in microtectonics
Text / Reference Books:	1. Fossen H,2010 – Structural Geology, Cambridge University Press, 1st edition 2. Ghosh S.K.,2014 – Structural Geology Fundamentals and Modern Concepts, Pergamon Press UK Indianedition 3. Passchier C.W. and Throuw R.A.J.,2005 – Microtectonics, Springer-Verlag, Heidelberg- 2nd edition 4. Ramsay J.G.,1967 - Folding and Fracturing of Rocks, McGraw-Hill New York, N.Y. 5. Ramsay J.G and Huber M.I., 1983- Techniques of Modern Structural Geology, Volume 1- StrainAnalysis, Academic Press **6.** Ramsay J.G and Huber M.I., 1983- Techniques of Modern Structural Geology, Volume 2- Folds andFractures, Academic Press **7.** Turner, F.J and Weiss,L.E.,1963-Structural Analysis of Metamorphic Tectonites, McGraw-Hill NewYork,N.Y.

Title of the Course and Course Code	GLY -553: Engineering Geology and Geotechniques	Number of Credits : 04
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Define the engineering properties of rocks.	
CO2	Infer different geo-hazard zones in a given area.	
CO3	Apply the knowledge of geological parameters in construction of engineering structures.	
CO4	Analyze slope stability in an area.	
CO5	Determine appropriate sites to build various engineering structures.	
CO6	Plan and carry out geotechnical investigation in the field.	

Unit. No.	Content
Unit I	**Rock Mass Characterization** Scope of Engineering Geology. Engineering properties of rocks. Methods of determining engineering properties of rocks. Behavior of rocks under stress. Rock failure mechanisms. Engineering properties of soils. Methods of soil investigations.
Unit II	**Geotechnical Studies** Drilling in geotechnical field and Drilling Equipments, Rock Quality Designation (RQD) and Core Recovery (CR) Core logging and bore logging RMR (Rock Mass Rating) (Bienawiski, 1989) Types of foundations and Safe Bearing Capacity Laboratory and field Geotechnical test
Unit III	**Engineering Structures** Geological considerations for the selection of various sites. Dam sites and types of Dams and Spillways. Forces acting on Dam wall. Reservoir competency. Silting of reservoirs. Tunnels: Tunnel sites and Tunnel alignment. Bridges, Y ducts Roads and similar structures
Unit IV	**Slope Stability Analysis** Applications Remote Sensing in Engineering Geology Types of Synthetic materials used as remedial measures. Estimation of Over-burden thickness and Rock strata classification. Preparation of Report and Presentation of Engineering data. Building Stones and Road Material Aggregates: Classification, Aggregate resources development

Reference books	Blyth, F G H. A geology for engineers. -7th ed Krynine and Judd: Principles of Engineering Geology and Geotechniques. Parbin Singh, Engineering Geology, S.k.Kataria& Sons Rise and Wateson: Elements of Engineering Geology.

Title of the Course and Course Code	**GLY -554: Environmental Geology**	**Number of Credits : 04**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Describe environmental issue.	
CO2	Understand various pollution and controlling measure.	
CO3	Categorized the environmental	
CO4	Classify natural hazard and their effect	
CO5	Review the effects of mining on environment.	
CO6	Apply environment suitable strategies for hazards mitigation.	

Unit. No.	**Content**
Unit I	• **INTRODUCTION TO ENVIRONMENTAL GEOLOGY AND SCOPE** • Fundamental concepts of environmental geoscience, its scope and necessity. • Definition, structure, composition and general characteristics of lithosphere, hydrosphere, atmosphere and biosphere. • Biogeochemical cycles of carbon, nitrogen, phosphorus and sulfur.
Unit II	**ENVIRONMENTAL ISSUES** • Water pollution and other Issues: Drinking water sources, quality criteria and standards, Characteristics of water, Types of water pollution, Groundwater pollution source, Pathways and mechanism, Attenuation process, Case histories of natural (arsenic and fluoride poisoning) and man-made water pollution. • Soil pollution: Soil formation, Classification and properties, Soil salinity and alkalinity, Characteristics of saline/ alkali soils, Soil amendments. Soil pollution sources, causes and effects. Soil pollution control measures. • Wetlands and Desertification of Lands
Unit III	**NATURAL HAZARDS, ZONING, RISK ASSESSMENT AND MANAGEMENT** • Extreme events and hazards, Catastrophic geological hazards, Study of landslides, Subsidence, Floods, Droughts, Earthquake, Volcanoes, their causes, classification, assessment, prediction and prevention. Coastal hazards, cyclones, tsunamis and shoreline and sea level changes. Strategies for hazards mitigation.

Unit IV	**MINING AND ENVIRONMENT** • Mining and its impact on environment, Wastes from mining industry, Waste disposal methods, Acid mine drainage, Heavy metal pollution due to mining, Environmental impacts of coal utilization, Fly ash, Recycling of resources and management. Reclamation and Rehabilitation (R&R) of Mined out area
Reference books	1) Keller: Environmental Geology. 2) Tank: Environmental Geology. 3) A.D. Howward and I. Remson: Geology in Environmental Planning. 4) Strahler and Strahler: Environmental Planning. 5) Ordway: Earth Science and Environment. 6) Turk and Turk: Environmental Geology. 7) K.S.Valdiya: Environmental Geology. 8) Bryant E.: Natural Hazards, Cambridge University Press. 9) Bell F.G.: Geological Hazards. 10) Smith K.: Environmental Hazards.

Title of the Course and Course Code	**GLY -560: On Job Training / Field Project**	**Number of Credits : 04**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Understand the basics of field mapping.	
CO2	Carry out flow mapping in DVP.	
CO3	Preparation of lithosections, sample collection in the field.	
CO4	Perform petrography	
CO5	Create lithologs based on field collected field data	
CO6	Prepare geological map and produce a report by carrying out geological mapping on field.	

	Content
	Fieldwork Component 1.Flow mapping of a suitable section in Deccan Volcanic Province 2. Field Tour of minimum 10 to 15 days in a suitable geological terrain to learn the methods of geological mapping 3.Prepration of geological map and writing report.

Title of the Course and Course Code	GLY -570: Practical - III	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Identify and describe sedimentary rocks and primary sedimentary structures.	
CO2	Classify sedimentary rocks using calculations on grain size and shape.	
CO3	Carry out plane table survey	
CO4	Explain different geo-engineering techniques for suitability of site.	
CO5	Analyse hydrochemistry of given samples	
CO6	Comment on suitability of water samples for various purposes	

Unit. No.	Content
	Practical III 1. Size analysis, Shape (Calculation and Classification) 2. Megascopic and Microscopic studies of sandstones and carbonates 3. Study of sedimentary structures (Primary and Secondary) and their environmental significance 4. Construction of lithofacies maps for environmental interpretations 5. Construction and Study of vertical profile section of some selected sedimentary environments, Paleocurrent Analysis 6. Provenance Analysis (a)using sandstone compositions; (b) using heavy minerals **Elective 1:** 1. Study of seismic and flood prone in India; 2. hydrochemistry analysis surface water and subsurface water; classification of groundwater for use in drinking, irrigation and industrial purposes **Elective 2:** 3. Various methods of Surveying used in engineering geology. 4. Plane table surveys, use of dumpy level and theodolite, Magnetic Compass Survey.

Title of the Course and Course Code	GLY -571: Practical - IV	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Perform structural geology problems using different techniques	
CO2	Classify geological material based on engineering properties.	
CO3	Analyse given structural data by various techniques.	
CO4	Perform RQD/RMR analysis on the borelog.	
CO5	Solve beta and pi diagrams	
CO6	Evaluate environmental impact on an area	

Unit. No.	Content
	Practical IV 1. Solution to structural geology problem by orthographic projection 2. Solution to structural geology problem by using equal area net 3. Completion of outcrops, Construction of geological cross sections and interpretation ofgeological maps 4. Statistical use of equal area net, beta and pi diagrams 5. Fault plane solutions 6. Fold reconstruction using Busk Method 7. Analysis of strain from deformed fossils 8. Mesoscopic analysis, Analysis of deformation and Metamorphism using thin sections **Elective 1:** 1. chemical analysis of water and soil sample; data and plotting 2. chemical classification diagram; evaluation of environmental impact of air pollution and groundwater pollution; deforestation; landslides **Elective 2:** 3. Demonstration of engineering properties of geological materials. 4. Interpretation of bore-hole data, Preparation of bore logs / lithologs/RQD/RMR.