Deccan Education Society's
Fergusson College (Autonomous)
Pune - 411004

Curriculum

as per guidelines of

NEP-2020

for

M. Sc. (Geology) Part I and II

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	Geomorphology, Remote Sensing and GIS	**4**
	GLY -504	Natural Resource Management	
	GLY -510	Research Methodology	**4**
	GLY -520	Geology Practical I	**2**
	GLY -521	Geology Practical II	**2**
		Total Semester Credits	**20**
II	**GLY -551**	Sedimentology	**4**
	GLY -552	Structural Geology	**4**
	GLY -553 OR	Principles of Stratigraphy and Palaeontology	**4**
	GLY -554	Environmental Geology and Disaster Management	
	GLY -560	**On Job Training**	**4**
	GLY -570	Geology Practical III	**2**
	GLY -571	Geology Practical IV	**2**
		Total Semester Credits	**20**
		Total PG-I Credits	**40**

Semester	Paper Code	Paper Title	Credits
III	**GLY -601**	Indian Stratigraphy	**4**
	GLY -602	Exploration Methods	**4**
	GLY -603 OR	Engineering Geology and Geotechniques	**4**
	GLY -604	Marine Geology	
	GLY -610	**Research Project**	**4**
	GLY -620	Geology Practical V	**2**
	GLY -621	Geology Practical VI	**2**
		Total Semester Credits	**20**
IV	**GLY -651**	Indian Mineral Deposits and Mining Geology	**4**
	GLY -652	Hydrogeology and Groundwater Development and Management	**4**
	GLY -653 OR	Petroleum Geology and Oil Field Practices	**4**
	GLY -654	Sequence Stratigraphy and Micropalaeontology	
	GLY -660	**Research Project**	**6**
	GLY -670	Geology Practical VII	**2**
		Total Semester Credits	**20**
		Total PG-II 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- II, Semester III		
Title of the Course and Course Code	**GLY -601: Indian Stratigraphy**	**Number of Credits : 04**
	Course Outcome (COs) **On completion of the course, the students will be able to:**	**Cognitive level**
CO1	Identify the different Stratigraphic units in India.	1
CO2	Categorize different lithostratigraphic units in India	2
CO3	Correlate spacio-temporal relationship of stratigraphic units in India	3
CO4	Explain stratigraphic framework of Himalaya.	4
CO5	Critique on different stratigraphy boundary problems in India.	5
CO6	Integrate information on different stratigraphic units to understand the stratigraphic framework of India.	6

Unit. No.	Content
Unit I	**Precambrian Stratigraphy of Peninsular India – I** Precambrian Stratigraphic framework of India. Dharwar Craton. Bastar Craton. Singbhum Craton. Aravalli Craton, Bundelkhand and Chota Nagpur Craton South Granulitic Terrain Proterozoic Mobile Belts:Pandyan Mobile Belt, Eastern Ghat Mobile Belt, CITZ Precambrian Igneous rocks
Unit II	**Precambrian Stratigraphy of Peninsular India – II** Stratigraphy, tectonics, Depositional Environment and Correlation of the following Proterozoic Basins/ Purana formations in India: Vindhyan Basin Cuddapah Basin Pranhita-Godavari Basin Bhima Basin Kaladgi Basin Chhattisgarh Basin
Unit III	**Stratigraphic framework of the Himalayas** Precambrians of the Extra Peninsular Region Paleozoic sequences of Himalaya from Spiti region. Mesozoic of Spiti. Geology of the Indus –Suture Zone, Geology of the Shyok –Suture Zone, Stratigraphy of North-Eastern region of India The Trans-Himalayan and Karakoram Granite Batholith. Stratigraphy and tectonics of the Siwaliks.

Unit IV	**Phanerozoic Stratigraphy of the Peninsular Region** Stratigraphic Boundaries in India –Archean- Proterozoic, Precambrian-Cambrian, Permo- Triassic, K-T Gondwana Sequence Jurassic of Kachchhand Jurassic of Rajasthan Cretaceous of Narmada valley/ Bagh Beds, Cretaceous of Tamil Nadu and Meghalaya Deccan Volcanic Province. Cenozoic of off shore –Krishna-Godavari Basin and Assam, Andaman-Nicobar Arc Quaternaries of Peninsular India.
Reference books	Radhakrishna B.P. &Vaidyanadhan R, Geology of Karnataka, 2011, Geological Society of India Mathur U.B., Quaternary Geology: Indian Perspective, 2005, Geological Society of India Ramakrishnan M andVaidyanadhan R, Geology of India (Vol. 1 & 2), 2010, Geological Society of India Saha A.K.: Crustal Evolution of Singhbhum-North Orissa, Eastern India, 1994, Geological Society of India

Title of the Course and Course Code	GLY -602: Exploration Methods	Number of Credits : 04
	Course Outcome (COs) **On completion of the course, the students will be able to:**	**Cognitive level**
CO1	Describe procedures of different exploration techniques.	1
CO2	Explain seismic data processing / concept of anomaly.	2
CO3	Apply various exploration techniques for mineral and energy exploration.	3
CO4	Analyze the data generated from various exploration methods.	4
CO5	Determine appropriate method for geophysical and geochemical exploration	5
CO6	Plan suitable geoexploration investigation of given problem /area.	6

Unit. No.	Content
Unit I	Gravity method- Introduction, Principles, Types of Gravimeters, Concept of Bouguer Anomaly- Generalised interpretation of Gravity data- Salient Case Studies. Magnetic Method- Introduction, Principles, Types of magnetometers- Magnetic anomalies and their interpretation- Salient Case Studies. Air borne surveys in Gravity and Magnetic Methods
Unit II	Seismic Method- Introduction and Principles Seismic Reflection Method Seismic Refraction Method Seismic instruments and Field procedures Processing of Seismic data and Salient Case Studies.
Unit III	Electrical Method- Introduction, Principles and Anomalies Resistivity Method- Introduction, Principles and Interpretation of resistivity data and Salient Case Studies. Self-potential Method- Origin of self-potential instrumentation and field procedure and Salient Case Studies Induced polarization method- Electrolytic and Electrode polarization- Instruments and field procedure and Salient Case Studies. Electromagnetic method- Principles, Instruments and Salient Case Studies. Magnetotelluric Methods- Principle, Instruments, Field Procedure and Salient Case Studies. Ground Penetrating Radar- Principles and Applications.
Unit IV	Geochemical methods- Introduction,Geochemical Anomaly, Geochemical cycle and Dispersion patterns. Geobotonical indicators of minerals. Surface and subsurface sampling methods Case studies
Reference books	Dobrin MB, Introduction to Geophysical Prospecting, 2014, Mcgrawhill Exclusive Hawkes HE, Principles of Geochemical Prospecting, 1957, US Government Printing Office Kearey and Brooks,An Introduction to Geophysical Exploration, 2016, Wiley India Paransis D.S., Principle of applied geophysics, 1997, Chapman& Hall Ramakrishna T.S., Geophysical Practice in Mineral Exploration& Mapping, 2006, Geological Society of India

Title of the Course and Course Code	GLY -603: Engineering Geology and Geotechniques	Number of Credits : 04
	Course Outcome (COs) **On completion of the course, the students will be able to:**	**Cognitive level**
CO1	Identify the engineering properties of rocks	1
CO2	Explain rock mass characterization	2
CO3	Execute slope stability analysis	3
CO4	Plan and carry out geotechnical investigation in the field.	4
CO5	Evaluate geological data for appropriate sites to build various engineering structures	5
CO6	Synthesis geological and engineering data to determine suitability of site	6

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 -604: Marine Geology	Number of Credits : 04
	Course Outcome (COs) **On completion of the course, the students will be able to:**	**Cognitive level**
CO1	Describe topographic features and marine environments	1
CO2	Discuss stratigraphy and tectonics of the oceans	2
CO3	Outline ocean circulation	3
CO4	Classify Ocean Margins and Oceanic Sediments	4
CO5	Decide the techniques in marine sampling and mapping	5
CO6	Integrate the data on Palaeoceanography & Quaternary Climate Change	6

Unit. No.	Content
Unit I	**Morphology, Stratigraphy and Tectonics of Oceans** **Geophysics & Ocean Morphology-** Introduction and brief history of marine geology; Principal Topographic Features (Continental Margins, Continental Shelf, Continental Slope, Continental Rise, Abyssal Plains, Oceanic Ridges, Abyssal Hills, Trenches, Volcanic Arcs); Driving Mechanisms of Plate Tectonics; Seismicity and Plate Tectonics; Volcanism and Plate Tectonics **Marine Environments**- Reefs, Estuaries & Coasts (Supratidal, intratidal, intertidal); Neritic and Oceanic Systems; Photic and Aphotic zones; Benthic Realm (Intertidal, Subtidal, Bathyal, Abyssal, Hadal); Pelagic Realm (Epi-, Meso-, Bathy-, abysso- and hado- pelagic). **Marine Stratigraphy**- Primary objectives of marine stratigraphy; Lithostratigraphy, Biostratigraphy, Sequence Stratigraphy; Magnetostratigraphy (Oceanic Magnetic Stripes, The Palaeo-magnetic time scale, Age of Oceanic Crust, Magnetic Quiet Zone and Spreading Rate Differences and Temporal Oscillations**);** Oxygen-Carbon Isotope Stratigraphy; Chronostratigraphy (Varve Chronology, Tephrochronology) **Tectonic history of Oceans-** How different oceans evolved over time (In brief)

Unit II	**Ocean Circulation** **Ocean Crust-** Structure, Petrology and Sources of Oceanic crust; Origin and Differentiation of Magmas; Crustal changes after formation; Magnetization of Oceanic crust) **Ocean Circulation-** Vertical and lateral stratification of the water column (Temperature, Salinity, Density distribution); Thermocline-Pycnocline; Oxygen Minimum Zone; Carbonate Conpensation Depth, Aragonite Compensation Depth, Importance of Wind; Corriolis Effect; Gastrophic Currents; Ekman Spiral and Upwelling; Convergence and Divergence of winds; Surface Currents; Bottom water circulation (The Conveyor Belt) **Sea Level History and Seismic Stratigraphy-** Importance of Sea-level changes and its causes; Quaternary Sea Level History; Coastal sea level changes and records; Seismic Sequence Stratigraphy and relative sea level changes **Near shore geological processes and the continental shelf-** Sediment disequilibrium in coastal zone; Coastal dynamics (Waves, Tides Currents coastal environments of deposition and erosion (estuaries, lagoons, beaches); Continental Shelf (Topography and Sedimentation)
Unit III	**Ocean Margins and Oceanic Sediments** **Continental margin types:** Divergent, Convergent and Transform margins, their development, characteristics and geographic distribution **Terrigenous deep sea sediments:** Size Classification and Compositional classification; global distribution; Gravity Transport (Fluidized sediment flow, grain flow, debris flow, turbidity flow); Submarine Canyons; Deep Sea Depositional Sites (Turbidity Fans, Deep Sea Fans, Abyssal Cones, Abyssal Plains); Hemipelagic Sediments; Deep Sea Clays; Wind-blown sediments; Volcanic Marine Sediments; Glacial Sediments; Extra-terrestrial sources of sediments **Biogenic and authigenic oceanic sediments:** Carbonate Oozes and pelagic carbonate; Siliceous Oozes and Chert; Factors controlling distribution, preservation and dissolution of biogenic sediments; Sinking of Pelagic Sediments; Metal rich sediments and oxides; Poly-metallic nodules and Manganese Nodules, their formation and distribution; Phosphorites; Zeolites; Marine Barites
Unit IV	**Trends in Geological Oceanography and Scope** **Techniques in marine sampling and mapping:** Grab Sampling, Core Sampling (Box Coring, Gravity, Piston, Hydraulic Piston, Multi-coring, Vibro-coring); Seismic Mapping (Echo-sounding, Multi-beam echo-sounding), DSDP-ODP Programmes (Objectives and Agencies involved, accomplishments and future directions); Data Buoys and Early Warning Systems **Palaeoceanography & Quaternary Climate Change-** Objectives, Deep sea

	records, Climatic change over geological time, concepts and proxies, Climatic cycles and their causes (Solar cycles, sea level variations, glaciations deglaciation); Patterns and causes of Quaternary Climate Change, Pleistocene Ice Sheets, LGM, Younger Dryas, Solar Cycles, Milankowich Cycle), Climatic variations in the Holocene **Coastal Hazards & Marine pollution-** Tsunamites and climatic disasters, CRZ and geological implications of man-made changes (Industrial effluents and coastal development, Reclamation and habitat conversion of coastal land, coastal erosion, oil slicks and shipwrecks, environmental impact assessment); Placer and sand mining **Exclusive Economic Zones and status of mineral resources-** (Oil & Natural Gas, Gas Hydrates, Poly-metallic nodules and Placer mineral deposits) and techniques and agencies involved in their exploration/exploitation
Reference books	Jon Erickson, Marine Geology, 1971, Prentice-Hall J P Kennett, Marine Geology, 1981, Pearson Condie Kent C., Plate Tectonics and Crustal Evolution, 1997, Butterworth-Heinemann Ltd Eugen Seibold and Wolfgang Berger, The Sea Floor: An Introduction to Marine Geology, 2017, Springer

Title of the Course and Course Code	**GLY -610: Research Project**	**Number of Credits : 04**
Guidelines for **Research Project** for Post Graduate Students under NEP2020 are to be referred on College Website		

Title of the Course and Course Code	GLY -620: Practical V	Number of Credits : 04
	Course Outcome (COs) **On completion of the course, the students will be able to:**	**Cognitive level**
CO1	Identify rocks related to different geological formations/cratons	1
CO2	Compare different paleogeographic maps of India	2
CO3	GLY603 Carry out plane table survey GLY604 Interpret bathymetric cross-section	3
CO4	GLY603 Analyse geotechnical data GLY604 Catagorise rocks of oceanfloor	4
CO5	GLY603 Determine methodology for a geotechnical investigation GLY604 Assess coastal toposheets and hydrographic sheets	5
CO6	Design and carryout a geotechnical survey	6

Unit. No.	Content
	GLY -601 • Study of typical hand specimens of rocks from different lithological units of Indian Stratigraphy. • Study of Palaeogeographical maps of India for different geological periods. • Study of geological maps of different units of Indian Stratigraphy. • Interpretation of regional geological maps. **GLY -603** • Various methods of Surveying used in engineering geology. • Plane table surveys, use of dumpy level and theodolite. • Magnetic Compass Survey. **OR** **GLY -604** • Reading coastal toposheets and hydrographic sheets • Preparing bathymetric cross-sections using Hydrographic sheets • Study of rocks of ocean floor • Distribution of major bathymetric and tectonic features in the global oceans **Fieldwork** Performing geotechnical survey or field traverses.

Title of the Course and Course Code	GLY -621: Practical VI	Number of Credits : 04
	Course Outcome (COs) **On completion of the course, the students will be able to:**	**Cognitive level**
CO1	Study Bouger anamoly maps	1
CO2	Interpret seismic data	2
CO3	Calculate different gravity corrections from the given data	3
CO4	GLY603 Analyse bore-hole data GLY604 Identify and describe marine sediments	4
CO5	GLY603 Outline engineering properties of geological material GLY604 Catagorise different marine sediments to bathymetric settings	5
CO6	Design and carryout resistivity survey	6

Unit. No.	Content
	GLY -601 • Study of patterns of geophysical responses from various geological mediums. • Plotting a Drift curve for an observed gravity data to which an elevation correction is applied, Plotting and interpretation of gravity profiles, Simulations of causative bodies. • Study of maps related to Gravity and Magnetic anomalies • Analysis of seismic refraction data for velocities and thickness of sub-surface layers. • Interpretation of Seismic Data • Plotting, collection and interpretation of resistivity data. **GLY -603** • Demonstration of engineering properties of geological materials. • Interpretation of bore-hole data. • Preparation of bore logs/ lithologs/RQD/RMR. **OR** **GLY -604** • Identification of oozes and authigenic sediments • Study of hand-specimens and thin sections of beach rocks • Distribution of carbonate and siliceous oozes, glacio-marine, pelagic clay and volcanogenic sediments in global oceans • Grain-size analysis using pipette analysis • Assigning different kinds of marine sediments to different bathymetric settings • Study of important global surface and deep water currents, with special emphasis on the 'Conveyor Belt'

M. Sc. Part- II, Semester IV		
Title of the Course and Course Code	**GLY -651: Indian Mineral Deposits and Mining Geology**	**Number of Credits : 04**
	Course Outcome (COs) **On completion of the course, the students will be able to:**	**Cognitive level**
CO1	Describe the mineralizing processes	1
CO2	Discuss the occurrence of economic minerals with space and time	2
CO3	Outline the industrial specifications of geological raw material	3
CO4	Explain drilling methods	4
CO5	Determine appropriate mining methods	5
CO6	Prepare a mining plan	6

Unit. No.	Content
Unit I	Scope and Application of economic geology. Concept of metalliferous and non metalliferous deposits, ore, gangue, tenor, grade, resources, reserves etc. Mineralization related to Plate tectonics, Structural controls on ore localization. Primary and Secondary ore forming process-Metallic & non-metallic Deposits Genetic classification of ore deposits- Stratiform, Stratabound, Porphyry, Volcanogenic Massive Sulphide deposits, Sedex deposits.
Unit II	Mode of occurrence, geological and geographic distribution, Classification of the following mineral deposits. Chromium, Iron, Manganese, Copper, Lead and Zinc Gold, Aluminum (Bauxite), Molybdenum, Coal, Uranium, Thorium, Carbonatites and rare earth elements. Introduction to Mineral Economics Concept of Strategic minerals Indian Mineral Policy
Unit III	**Guides to Ore and Drilling Methods** Concept of reserve and resource- Resources classification, EMG classification Deterministic methods and Probabilistic Methods Concept of ore blending- Numerical concept of volume and weightage, Estimation of bulk density, Assay classification Ringed Target and Intersecting loci Regional and Topographical Guides Mineralogical Guides Structural Guides Stratigraphic Guides Types of Dills - Percussion Drills,Rotary Drills, Miscellaneous Drills

Unit IV	**Mining Methods – Open Cast and Underground Cast** Mining Methods- Selecting Mining Machinery, Alluvial Mining Introduction to the terminologies used in exploration and exploitation of the ore in the mine -Mining methods Concept of exploration and mining license (National Mineral Policy) Strategic minerals Concept of national Wealth-Basic Mining law, Market Analysis Preparation of Mining Plan and Mining Scheme and Mine Closer Plan
Reference books	• Bateman AM, Economic Mineral Deposits, 1981, John Wiley & Sons Inc • Dolbear Samuel H, Industrial Minerals and Rocks (Nonmetallics other than Fuels), 1949, The American Institute Of Mining • And Metallurgical Engineers New York • Jain S.K, Mineral Processing, 2008, CBS Publishers & Distributors Rajendran, Aravindan, Srinivasamoorthy,Mineral Exploration- Recent Strategies, 2007, New India Pub • Umeshwar Prasad, Economic Geology - Economic mineral deposits 2e, 2016, CBS Publishsers and Distributors • Gaudin A.M, Principles of Mineral Dressing,1939, McGraw Hill, NewYork • Ghose AK, Prof.B.B.Dhar, Mining Challenges of 21st Century,2000,A.P.H.Publishing Coperation, Delhi • PanigrahiD.C,Mine Environment and Ventilation,2001,CRC Press • Singh OP, Mining Enviroment,Problems& Remedies,2005 Regency, New Delhi • Singh RB, P. Pal Roy, Blasting in Ground Excavation and Mines,1993, A Balkema Publishers

Title of the Course and Course Code	GLY -652: Hydrogeology, Groundwater Development and Management	Number of Credits : 04
	Course Outcome (COs) **On completion of the course, the students will be able to:**	**Cognitive level**
CO1	Describe aquifer and its characteristics	1
CO2	Summaries typology of a given area by studying its various aspects	2
CO3	Outline well hydraulics	3
CO4	Explain different hydrogeological investigative methods	4
CO5	Critique on groundwater governance, policies and legislations	5
CO6	Propose watershed development measures	6

Unit. No.	Content
Unit I	**Hydrogeology** Rock hydrologic properties Factors controlling accumulation and movement in different rocks Lithological and structural and controls on groundwater occurrence The concept of aquifer and types of aquifers; Concept of watersheds, Groundwater accumulation and movement Groundwater and Watersheds Aquifer properties; Concept of aquifer mapping Concept of Hydrosphere and the hydrologic cycle, Scope and Importance(Uses) of Groundwater, Age of Groundwater Climate, topography and geology: their influence on groundwater
Unit II	**Hydrogeology** **Wells, Well Hydraulics, Groundwater Quality and Distribution in India** Well Inventory Well hydraulics: Principles, Procedures and Concept Pumping tests: i) Well tests, ii) Aquifer Performance testsiii) Slug tests Quality of Groundwater Springs and base flows Groundwater Exploration Techniques
Unit III	**Groundwater Development and watershed development** Wells (types) design and construction, well characteristics Groundwater Monitoring Concept of integrated aquifers and watershed development in relation to groundwater resources Rainwater and rooftop harvesting codes Sea water ingress and mitigative measures
Unit IV	**Groundwater Management and Governance** **Groundwater Management** Groundwater Balance equation for watershed (Groundwater assessment in a region) Groundwater Budget (Village water audit) Conjunctive use of surface and groundwater resources Participatory Ground Water Management (PGWM) and Community Based Ground

	Water Management (CBGWM) Concept of Water User Groups: Case studies Protocols of Ground Water Management **Groundwater Governance** Policy, Legislationand Institutions Role of NGOs, Panchayati Raj Science, policy and regulatory frameworks: integrating disciplines Typology concept in groundwater management, Groundwater Modeling Groundwater provinces in India,Groundwater in Maharashtra State
Reference books	Davis S.N. and Dewiest R.J.M.: Hydrogeology 1968, John Wiley & Sons Fetter CW,Applied Hydrogeology, 4th Edition,2001, Pearson Karanth, K.R.: Groundwater Assessment Development and Management 1e, 1987, Tata McGraw-Hill Education Publishers Raghunath, H.M.: Groundwater, Wiley Eastern Ltd Todd, D.K.: Groundwater Hydrology 3e, 2015, Wiley India Exclusive

Title of the Course and Course Code	GLY -653: Petroleum Geology and Oilfield Practices	Number of Credits : 04
	Course Outcome (COs) **On completion of the course, the students will be able to:**	**Cognitive level**
CO1	Describe origin and occurrence of petroleum	1
CO2	Comprehend the migration and accumulation processes of petroleum.	2
CO3	Describe various drilling methods and techniques.	3
CO4	Summarize various aspects of oil exploration.	4
CO5	Analyze various types of logs.	5
CO6	Compose geological parameters in oil exploration	6

Unit. No.	Content
Unit I	**Petroleum Geology** Origin and Occurrence of Petroleum Origin of Petroleum (Kerogen and Biomass), Organic and inorganic occurrence. Nature of source rock. Chemical Classification and composition of Petroleum and oilfield water Physical properties of petroleum.
Unit II	**Petroleum Geology** Migration and Accumulation of Petroleum Reservoir rock, types and classification Types of traps and seals Migration and accumulation of petroleum. Petroliferous basins of India Unconventional reservoirs- Indian examples
Unit III	**Drilling Operations in Oil Field** Types oil wells and geotechnical order Methods of Oil well drilling Types of Drilling Rigs Rotary drilling Drilling Mud Concept of Subsurface pressure. Directional Drilling Coring: Introduction and Techniques
Unit IV	**Formation Evaluation** Well logging- Techniques, Principles and Instrumentation Interpretation of logs Mud logging: Principle, Techniques, Tools and Interpretation MWD (Measurement While Drilling)/LWD (Logging While Drilling): Principle, Tools of MWD/LWD, Data Analysis and Interpretation. Formation (Drillstem) Testing: Introduction, Tools and Techniques of DST, Retrievable Formation Tester (RFT) Life cycle of an oil field Geophysical Prospecting Methods in Brief

	Low resistivity oil reservoirs
Reference books	Bjorlykke, Knut, Petroleum Geoscience, 2015, Springer-Verlag Berlin Heidelberg Leverson, Geology of Petroleum, 2006, CBS Publishers & Distributors P. L. Zutshi, M. S. Panwar, Geology of petroliferous basins of India, 1997, KDM Institute of Petroleum Exploration Hearst and Nelson and Paillet, Well Logging for Physical Properties2000, John Wiley & Sons Kennedy JL, Fundamentals of drilling--technology and economics1983, PennWell Rider M. H., The Geological Interpretation of Well Logs, 1996, Whittles Publishing

Title of the Course and Course Code	GLY -654: Sequence Stratigraphy and Applied Micropalaeontology	Number of Credits : 04
	Course Outcome (COs) **On completion of the course, the students will be able to:**	**Cognitive level**
CO1	Describe the interdisciplinary nature of sequence Stratigraphy.	1
CO2	Classify various microfossils	2
CO3	Compare different sedimentological environments	3
CO4	Explain applications of micropalaeontology	4
CO5	Evaluate the paleoclimatic conditions	5
CO6	Recognize stratigraphic surfaces	6

Unit. No.	Content
Unit I	**Sequence Stratigraphy** **Introduction to sequence stratigraphy** Historical Development, Interdisciplinary nature of sequence stratigraphy Fundamental concepts of sequence stratigraphy: definitions and terminologies Methods of Sequence Stratigraphic Analysis
Unit II	**Sequence Stratigraphy** **Basic concepts of Base level changes, accommodation and shoreline Shifts** Base level cycles, allogenic controls on sedimentation: significance and signatures, sediment supply and energy flux, sediment accommodation, shoreline trajectories Stratigraphic surfaces: types of stratal terminations, sequence stratigraphic surfaces, system tracts Clastic and Carbonate Facies Models.
Unit III	**Applied Micropaleontology1** Definition and scope Surface and subsurface sampling methods, Laboratory techniques andequipments for micropaleontological studies Geological Timescale. Calcareous Microfossils Foraminifera: morphology, biostratigraphicsignificance, application and paleobathymetric reconstructions. Calcareous algae: Classification, morphology and biostratigraphic significance; applications and paleobathymetric interpretation. Ostracoda: classification, morphology and biostratigraphic significance, applications and paleoclimatic studies. Introduction to Bryozoa: classification, morphology and biostratigraphic significance (In brief). Introduction to Calcareous Nannofossils, Outline morphology; biostratigraphic and paleoclimatic significance (In brief).

Unit IV	**Applied Micropaleontology 2** Siliceous Microfossils: Diatoms: morphology and classification, and Application Introduction to Silicoflagellates and Radiolaria, their morphology and significance (In brief) Organic walled Microfossils: Pollens and Spores: Morphology, ClassificationandApplications; Palynomorphs Introduction to Acritarch , Dianoflagellates and Phytoliths;
Reference books	Emery, D, Sequence Stratigraphy, 1996, Blachwell Scientific Publ. Miall, A.D., The Geology of Stratigraphic Sequence, 1997, Springer-Verlag. W.G.Hatlelid, Seismic stratigraphy and global changes of sea level, 1977, American Association of petroleum Geologists, Vol.26. Haq and Boersma, Introduction to Marine Micropaleontology, 1978, Elsevier. Jones RW, Micropaleontology in Petroleum exploration, 1996, Clarendon Press Oxford Kathal, P.K., Applied Geological Micropaleontology,2011, Scientific Publishers, Jodhpur. Kennett and Srinivasan, Neogene Planktonic Foraminifera: A phylogenetic Atlas, by, Hutchinson Ross, USA. 1983. Kundal, P. and Humane, S.K. (Eds.) Applied Micropaleontology, 2010, Gondwana Geological Society,V. 24 (1). Prothero, D.R., Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), 2004, McGraw Hill. Seaward, A.C., Plant fossils, Today's and Tomorrow, 1991, New Delhi. Wray, J.L., Calcareous Algae, 1977, Elsevier.

Title of the Course and Course Code	**GLY -660: Research Project**	**Number of Credits : 06**
Guidelines for Research Project for Post Graduate Students under NEP2020 are to be referred on College Website		

Title of the Course and Course Code	GLY -670: Practical VII	Number of Credits : 04
	Course Outcome (COs) **On completion of the course, the students will be able to:**	**Cognitive level**
CO1	Describe industrial specifications of the minerals	1
CO2	Calculate area influence using different methods	2
CO3	Analyze hydrogeological and hydrochemical data	3
CO4	GLY653Create maps and profiles for hydrocarbon accumulation site GLY654 Identify and examine microfossil assemblage to estimate paleo-depth	4
CO5	GLY653Evaluate logs and estimate the reserve GLY654 Analyze vertical profile sections to infer sedimentary environments	5
CO6	Design hydrogeological survey	6

Unit. No.	Content
	GLY -651 • Microscopy • Ore mineralogy • Industrial minerals • Mine valuation and calculation by uniform spacing on rectangular co-ordinate method. • Veins problems (linear groups, minimum stoping widths). **GLY -652** • Preparation of water level contour maps and their interpretation. • Analysis of pumping test data by simple graphical methods for determination of aquifer and well characteristics. • Plotting and analysis of hydro-geochemical data. **GLY -653** • Preparation of Isopach maps and Structural contour maps • Basic log interpretation. • Introduction, Aspects of Balance Cross Section and examples, Types of Cross Section, Applicability. **OR** **GLY -654** • Preparation of facies maps and facies diagrams. • Study of significant system tracts. • Techniques of separation of microfossils from matrix and preparation of slides. • Microscopic study of Calcareous, Siliceous, Phosphatic and organic walled microfossils.