DEPARTMENT OF APPLIED GEOLOGY

INDIAN SCHOOL OF MINES, DHANBAD

COURSE STRUCTURE AND SYLLABUS

FOR

2-YEAR M. TECH.

IN

ENGINEERING GEOLOGY

Proposed to be effective from 2012-13 onwards

Course structure for Two-year M. Tech. in Engineering Geology

(To be effective from 2012-2013 onwards)

I – SEMESTER

Sl. No.	Subject Code	Subject	L-T-P	Credit Hours
1	GLC 51101	Geotechnical Behaviour of Earth Materials	3-0-0	6
2	GLC 51102	Soil Engineering	3-0-0	6
3	GLC 51103	Structural Geology for Site Engineering	3-0-0	6
4	MEC 51151	Applied Rock Mechanics	3-0-0	6
5	MER511XX*	Mining Operations and Methods	3 0 0	6
6	GLC 51201	Geotechnical Behaviour of Earth Materials Practical	0-0-3	3
7	GLC 51202	Soil Engineering Practical	0-0-3	3
8	GLC 51203	Structural Geology for Site Engineering Practical	0-0-3	3
9	MEC 51251	Applied Rock Mechanics Practical	0-0-3	3
		Total	15-0-12	42

* Subject code to be provided by the Department of Mining Engineering

II – SEMESTER

Sl. No.	Subject Code	Subject	L-T-P	Credit Hours
1.	GLC52104	Geotechniques of Dams, Tunnels and Underground Space	3-0-0	6
2.	GLC52105	Rock Slope Engineering	3-0-0	6
3.	GLC52106	Environmental Geotechnology	3-1-0	7
4.	 GLE52107 GLE52108 GLE52109 GLE 52110	Elective (Any One) Contaminant Hydrogeology Remote Sensing and GIS Geohazard Analysis Geostatistical Methods	3-0-0	6
5.	GPC52151	Engineering Geophysics	3-0-0	6
6.	GLC52204	Geotechniques of Dams, Tunnels and Underground Space Practical	0-0-3	3
7	GLC52205	Rock Slope Engineering Practical	0-0-3	3
8.	GPC52251	Engineering Geophysics Practical	0-0-3	3
9.	GLC52508	Composite Viva-voce	0-0-0	2
		TOTAL	15-1-9	42

III – SEMESTER

Sl.No.	Course No.	Name of the course	L T P	Credit Hours
1.	GLC53601	Industrial Training / Minor Project	0 0 0	4
2.	GLC53402	Seminar / viva-voce on Industrial Training / Minor Project	0 0 0	2
3.	GLC53503	Composite Viva-voce	0 0 0	4
4.	GLC53804	Interim Dissertation (Field Work / Lab Work)	0 0 0	15
5.	GLC53405	Seminar and Viva-voce on Dissertation	0 0 0	10
6.	GLC53006	Evaluation of teaching assignment / Lab. Development work	0 0 0	5
		TOTAL	0 0 0	40

IV SEMESTER

Sl.No.	Course No.	Name of the course	L T P	Credit Hours
1.	GLC54801	Dissertation	0 0 0	20
2.	GLC54402	Seminar on Dissertation	0 0 0	5
3.	GLC54503	Viva-Voce on Dissertation	0 0 0	10
4.	GLC54004	Evaluation of teaching assignment / Lab development work	0 0 0	5
		TOTAL	0 0 0	40

I – SEMESTER

GLC51101	GEOTECHNICAL BEHAVIOUR OF EARTH MATERIALS	3-0-0

Intact rock and rock mass concepts, rock discontinuities and anisotropy, characterization of rock joints and jointed rock masses, Intact (crystalline) rock, stratified rock, weak rock (weathered rock and soft sediments), chemically weak rock (carbonates). Behavior of rock materials, rock and rock mass deformability, Stress and strain measurement and analysis, Elastic modulus, dynamic modulus and its importance in various engineering situations. Principal stresses; Mohr's circle. Shear strength, Shear stiffness and dilation. Rock joint shear strength and scale effects. Application of shear strength parameters in rock engineering projects. Rock mass classification, NGI – Q Index, RMR, GSI and other Classification schemes.

GLC51201	GEOTECHNICAL BEHAVIOUR OF EARTH MATERIALS PRACTICAL	0-0-3

Compressive Strength tests for weak sandstones, shales, and foliated metamorphic rocks. Exercises on Mohr's criteria. Determination of shear strength of joints by portable shear apparatus and Franklin direct shear testing machine. Slake durability test.

GLC51102	SOIL ENGINEERING	3-0-0

Factors influencing nature and formation of soils. Soil structure, types of bonds. Important clay materials. Engineering properties of soils, Genetic and engineering classification of soils, Complexity of soil nature. Permeability and flow through soil media, Soil stress and seepage, compressibility and consolidation. Shear strength of Cohesion-less and cohesive soils. Soil stress, effective stress, pore water pressure parameters. Earth pressures, active and passive. Stability analysis of soil slopes. Type of foundations, settlement of foundations, bearing capacity, pile foundations. Type of soils as an aggregate material.

GLC51202	SOIL ENGINEERING PRACTICAL	0-0-3

Determination of physical and engineering properties of soils: Atterberg limits, consistency limits, Direct shear strength triaxial shear (Drained and undrained test's). Permeability by falling head and constant head method.

GLC51103	STRUCTURAL GEOLOGY FOR SITE ENGINEERING	3-0-0

Scope of structural geology with special reference to engineering geology. Anisotropy and heterogeneity in deformed rocks, Geological stresses and strains, Geometric analysis of folds, faults, joints and rock cleavages. Structural evaluation of sites of construction: Preparation and interpretation of fence diagram, Structure contour maps, Isopach and isochore maps. Joint and fracture maps, Stereographic projections. Isometric projections, block diagrams, Fence diagrams. Geomorphic and structural evaluation of river valley projects – considerations.

GLC51203	STRUCTURAL GEOLOGY FOR SITE ENGINEERING PRACTICAL	0-0-3

Interpretation of topographic maps and geological maps, Preparation and interpretation of fence diagram. Structure contour maps, Isopach and isochore maps. Analysis of Fracture and Lineament array. Structural Geometry by stereographic projection. Construction profiles of folds. Analysis of stress.

MEC51151	APPLIED ROCK MECHANICS	3-0-0

Definition, importance and scope of the subject. Analysis of stress and strain at a point; Mohr's circle of stress and strain; stress field.
Physical and mechanical properties of rocks; compressive, tensile, shear and triaxial strength of rock; Behaviour of rock under stress/strain and creep in rocks rheological models.
Theories of rock failure: Coulmb-Navier Criteria, Griffiths criteria, Mohr's criteria.
Stress concentration around an opening.
Rock bursts and bumps. Subsidence - causes, prediction, monitoring and prevention case histories in Indian scenario.
Determination of in-situ stresses.
Instrumentation and monitoring of stability of structure in rocks. Stabilization of weak and fractured ground - grouting and shortcreting. Numerical modeling for Geotechnical applications.

MEC51251	APPLIED ROCK MECHANICS PRACTICAL	0-0-3

Direct and indirect methods of determination compressive, tensile, shear and triaxial strength of rock; modulus of elasticity and Poisson's ratio; dynamic modulus of elasticity; porosity of rock; load cell, extensometer and convergence meter.

MER511XX*	MINING OPERATIONS AND METHODS	3 0 0

Introduction to mining, elements of mining, definitions and explanation of different mining terms.

Introduction to surface mining; Deposits amenable to surface mining; Concept of stripping and stripping ratios. Box cut – definition, objectives, types and their applicability; Production benches – objectives, formation and parameters. Unit operations vis-a-vis equipments; Classification of surface mining systems. Rippling, drilling and blasting. Shovel-dumper and dragline operation.

Introduction to underground coal mining: Broad classification of underground coal mining methods. Bord and Pillar method – general description, panel system of mining and its advantages and disadvantages, determination of size of panel, development by SDL/LHD, Rib & Slice method of depillaring in one lift with caving in flat/moderately inclined seams. Longwall method – general description and application, Longwall advancing and Longwall retreating methods and their advantages and disadvantages, factors governing length of panel and length of Longwall face, introduction to PSLW technology with shearer.

Introduction to underground metal mining; Deposits amenable to underground metal mining. Modes of entry to underground mineral deposits. Mine development: drifting, raising and winzing; Classification of underground metal mining methods. General description, applicability and operations involved in different methods.

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II – SEMESTER

GLC52104	GEOTECHNIQUES OF DAMS, TUNNELS AND INDERGROUND SPACE	3-0-0

Dams: Types of Concrete dams. Geological site characterisation. Dam foundations and rock foundation problems. Treatment of foundations – Treatment of shear zones, dental treatment of shear zones. Earth and rock fill dams: Components of earth and rock-fill dams, their functions and use, Use of filters, aprons and blankets, treatment of foundations of earth and rock-fill dams. Reservoir induced seismicity. Case studies.
Treatment of foundation seepage. Percolation and water loss tests, lugeon tests, Grouting methods, grouting processes, grouting mixtures, consolidation and curtain grouting, Pressure grouting. Tests for efficiency of grouting and correlation for grout intake. Various types of rock bolting.

Tunnels and underground space: Types of tunnels: road, rail, hydropower, sewage etc. Tunneling methods. Geohydrological hazards in tunneling. Tunneling ground Classification: grounds with residual stresses, squeezing ground, swelling ground, ralveling ground, running ground conditions and methods in controlling such grounds, Terrain evaluation and site characterization for tunnels in rocks. Geotechnical problems associated with tunnels: stand-up time, bridging capacity of rocks, overbreaks, arching action. Stability of tunnels: Rock quality classification methods for evaluation of support requirements: rock bolting, shortcreting, rib-support and flexible support Tunneling in weak rocks. Tunneling instrumentation, *in situ* stress measurement tests.

GLC52204	GEOTECHNIQUES OF DAMS, TUNNELS AND UNDERGROUND SPACE PRACTICAL	0-0-3

Engineering geological map exercise on concrete dams, earth dams, road and hydropower tunnels, Exercises on preparing of foundation maps. Exercises on RQD and rock mass quality determination.

GLC52105	ROCK SLOPE ENGINEERING	3-0-0

Landslide classification, Natural landslides in soils and rocks. Types and modes of slope failure, Mechanics of landslides. Stability of slopes. Plane wedge and circular failures analyses. Hoek charts and graphical procedures. Hazard/Risk Zonation mapping of landslide prone areas. Instrumentation in landslides. Investigations. Collection of data and analysis of geological data, Stereographic method etc., Case studies. Slope analysis and factor of safety using limit equilibrium methods. Application of RMR/RSR classification in slope stability evaluation. Remedial measures for stabilizing slopes. Computer programmes for slope stability and computer aided design in rock slope engineering. Instrumentations for monitoring slope movements. Landslides in Himalayas. Case studies. Slope stability problems in opencast mines. Case studies.

GLC52205	ROCK SLOPE ENGINEERING PRACTICAL	0-0-3

Preparation of Engineering Geological Maps, Rock Slope Maps with reference to highways, Analysis of slope stability problems, Exercises on Plane, Wedge and Circular failure analysis, Use of software for solutions on Rock slope stability.

GLC52106	ENVIRONMENTAL GEOTECHNOLOGY	3-1-0

Engineering geological studies for environmental evaluation and development in rural, urban, mountainous mining, river valley project areas, etc. Environment issues related to environmental impact of large size dams and tunnels on ecosystem of river valley areas. Impact of diversion of rivers for power generation. Environmental aspects of opencast mining projects with emphasis on impact of mine dumps, hydrogeology, land reclamation and restoration. Impact of unplanned urbanization on groundwater regimes. Nuclear waste and disposal: Radiation and dangerous radioactive products and half life, natural and anthropogenic sources; radiation and health effects, high and low level radioactive wastes – site selection for nuclear waste disposal, case studies. Environmental planning, management and economics (EMP and EIA). Preparation of Project Feasibility Report

ELECTIVE (ANY ONE)

GLE52107	CONTAMINANT HYDROGEOLOGY	3-0-0

Introduction to contaminant hydrology: advection, dispersion, retardation, biodegradation of groundwater contaminants.
Low temperature aqueous geochemistry
Sources of contamination; chemical evolution of soil water and ground water
Solute transport in ground water; transformation, retardation and attenuation
Non-aqueous phase transport in ground water,
Monitoring contaminant migration. Use of isotopes in water contaminant and migration studies
Remediation technology and case studies

GLE52108	REMOTE SENSING AND GIS	3-0-0

A. **Remote Sensing**

1. Principles of remote sensing. The nature and generation of electromagnetic radiation. Spectral bands, resolution and reflectance curves, interaction of EMR with atmosphere, rocks, minerals and soil, vegetation and water. Sensor systems and platforms.
2. Aerial remote sensing, aerial photography, properties of aerial photographs, elements of photointerpretation. Interpretation of geographical, geomorphological, structural and lithological features from aerial photographs. Radar remote sensing. Satellite remote sensing: LANDSAT, SPOT and IRS systems. Introduction to digital image processing.
3. Applications: Remote sensing in Geological mapping, Mineral Exploration, Ground water Exploration, Petroleum Exploration, Engineering Geology and Environmental studies.

B. GIS

1. Geographical Information System: Introduction and definitions; Technology and concepts; Components of GIS; Developments in GIS.
2. GIS data modelling, data analysis – Overlay, DEM and DTM; Topological modelling; spatial operations, Map integration, Multi-criteria evaluation.
3. Steps in a GIS project: Identification of project objectives, Creation of project database, Analysis of data, and Data integration, and Presentation of map output.
4. Overview of GIS softwares.

GLE52109	GEOHAZARD ANALYSIS	3-0-0

Different geological hazards: earthquakes, volcanism, landslides, coastal hazards and flooding. Procedures and techniques to evaluate geological factors for geohazards. Environmental hazards due to intensive exploration of aquifers in coastal, mining and urban areas. Environmental hazards due to earthquake and floods. Regional subsidence.

GLE52110	GEOSTATISTICAL METHODS	3-0-0

Sampling Methods – Theory and Concepts. Classical Statistical methods: Univariate and Bivariate; Exploratory data analysis. Probability distributions: (i) Continuous distributions, viz. Normal (Gaussian), and Lognormal distributions and their fit to a sample distribution; (ii) discrete distributions, viz. Binomial, Negative Binomial and Poisson Distributions.
Concepts of Geostatistics; Semi-variogram: definition, characteristics and properties. Computation of semi-variograms; mathematical models of semi-variogram; Techniques of semi-variogram model fit.
Extension variance and Estimation variance: definition, derivation and calculation procedures.
Kriging: introduction and definition. Linear kriging. Derivation and solving kriging system of equations for point and block. Geostatistical conditional simulation.
Practical applications of Geostatistics in geotechnical investigation, hydrocarbon exploration and reservoir modelling with case studies.

GPC52151	ENGINEERING GEOPHYSICS	3-0-0

Seismic refraction. Elastic constants, effect of depth and age. Huygen's principle, Snell's law. Analysis of time and distance graphs. Non-parallel interface. Multilayered models. Velocity inversion. Correction. Electrical methods. Archie's law point current electrode on homogeneous earth. Heterogeneous medium field use – mapping procedure. Electrical sounding Schlumberger.
Sounding. Plotting. Quantitative interpretation. Two layer structures. Curve matching. Case studies regarding applications of geophysics in dam foundation and rock tunneling etc. projects. Neotectonics, seismotectonics, seismic zonation, ground vibration/acceleration, seismic wave alteration, induced seismicity.

GPC52251	ENGINEERING GEOPHYSICS PRACTICAL	0-0-3

Calculation of elastic constants from the seismic velocity and critical angle from Snell's law. Interpretation of travel time – distance curve for a horizontal reflector. Calculation of intercept time and crossover distance for a horizontal refractor and travel – distance curve for a dipping refractor. Drawing of travel time – distance curve for three layered earth. Calculation of Normal Move Out and Dip Move Out from reflected travel time. Interpretation of ascending and descending sounding curve for layered earth. Interpretation of bell shaped and bowl shaped sounding curve for layered earth. To plot and interpret resistivity profiling data.