Syllabus for All Indian Written Examination for Admission in M. Tech 2016 -17 Programmes of Indian School of Mines, Dhanbad

Name of subject: **Engineering Geology** **Code:** **EGL**

1. **Geomorphology and Remote Sensing**: Methods of geomorphic investigations. Evolution of different land forms. Applications of geomorphology in different geological investigations. Principles and applications of remote sensing.
2. **Stratigraphy**: Principles of stratigraphy. Stratigraphic classification. Stratigraphy and tectonics of Precambrian rocks of India. Phanerozoic stratigraphy of peninsular and extra-peninsular India.
3. **Paleontology**: Theories of organic evolution. Causes of extinction. Morphology of common invertebrate and vertebrate fossils. Micropaleontology and its applications. Paleobotany for exploration.
4. **Mineralogy and Geochemistry**: Crystal chemistry. Phase stability and properties of different mineral groups. Chemical evolution of the earth. Geochemical classification and distribution of elements. Geochemistry of important elements.
5. **Sedimentary Petrology**: Textures and structures of sedimentary rocks. Petrology of important sedimentary rocks. Paleocurrent analysis. Provenance studies. Sedimentary environments.
6. **Igneous Petrology**: Textures and structures of igneous rocks. Crystallization of magma and representations in phase diagrams. Representations of chemical analysis of igneous rocks and their applications and limitations. Petrology of different types of igneous rocks. Magmatism in relation to plate tectonics.
7. **Metamorphic Petrology**: Metamorphic textures. Kinetics of metamorphic reactions. Different types of projection diagrams. Stability of common metamorphic minerals. Geothermometry and geobarometry. Metamorphism of different rocks. Plate tectonics end metamorphism.
8. **Structural Geology**: Stress; strain; strain analysis; structural analysis of slate belts, poly-deformed terranes, shear zones and migmatites; analysis of thrust belts; mechanisms of folding and fracturing.
9. **Geotectonics**: Variations of physical properties in the earth. Crustal types and their evolution. Evolution of ocean basins. Tectonics of different types of plate boundaries with special reference to India.
10. **Economic Geology**: Classification of ore deposits. Evolution of different types of ore deposits. Origin, migration and accumulation of petroleum. Coal geology and nuclear geology.
11. **Exploration Geology**: Concepts of mineral exploration. Methods of geological and geochemical prospecting. Drilling. Evaluation of exploration data. Geophysical prospecting. Mineral beneficiation.
12. **Engineering Geology**: Engineering properties of rocks and soils. Geotechnical investigations for dams, reservoirs, tunnels and mass movements.
13. **Hydrogeology and Environmental Geology**: Hydrological characters of different rocks. Aquifer evaluation. Groundwater flow. Characteristics of ground water for different use. Groundwater development and management. Groundwater provinces of India. Environmental problems of mineral exploration. Low temperature geochemistry. Environmental planning and management.

Syllabus for All Indian Written Examination for Admission in M. Tech 2016 -17 Programmes of Indian School of Mines, Dhanbad

Name of subject: Mineral Exploration **Code: MEX**

1. **Geomorphology and Remote Sensing**: Methods of geomorphic investigations. Evolution of different land forms. Applications of geomorphology in different geological investigations. Principles and applications of remote sensing.
2. **Stratigraphy**: Principles of stratigraphy. Stratigraphic classification. Stratigraphy and tectonics of Precambrian rocks of India. Phanerozoic stratigraphy of peninsular and extra-peninsular India.
3. **Paleontology**: Theories of organic evolution. Causes of extinction. Morphology of common invertebrate and vertebrate fossils. Micropaleontology and its applications. Paleobotany for exploration.
4. **Mineralogy and Geochemistry**: Crystal chemistry. Phase stability and properties of different mineral groups. Chemical evolution of the earth. Geochemical classification and distribution of elements. Geochemistry of important elements.
5. **Sedimentary Petrology**: Textures and structures of sedimentary rocks. Petrology of important sedimentary rocks. Paleocurrent analysis. Provenance studies. Sedimentary environments.
6. **Igneous Petrology**: Textures and structures of igneous rocks. Crystallization of magma and representations in phase diagrams. Representations of chemical analysis of igneous rocks and their applications and limitations. Petrology of different types of igneous rocks. Magmatism in relation to plate tectonics.
7. **Metamorphic Petrology**: Metamorphic textures. Kinetics of metamorphic reactions. Different types of projection diagrams. Stability of common metamorphic minerals. Geothermometry and geobarometry. Metamorphism of different rocks. Plate tectonics end metamorphism.
8. **Structural Geology**: Stress; strain; strain analysis; structural analysis of slate belts, poly-deformed terranes, shear zones and migmatites; analysis of thrust belts; mechanisms of folding and fracturing.
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Name of subject: Earthquake Disaster, Hazard and Mitigation Code: EHM

Mechanics of Solids: Theory of elasticity. Modulus of elasticity. Analysis of stress and strain, principal stress and strain, principal planes, stress-strain relationships for different materials, generalized Hooke's law. Bending moments and deflection in beams and cantilevers. Rigid body kinematics and dynamics, analysis of structures. Distributed forces: Centroids, Centers of gravity and Moments of inertia.

The Solid Earth: Earth: its rotation and figure. Gravity and its variation over the earth, Earth: surface features, continents, continental margins, oceans. Earth's interior: physics status; variation of physical parameters and seismic wave velocities inside the earth. Major sub-divisions inside the earth. Composition and structure of the crust, concept of sea floor spreading and plate tectonics.

Near Surface Investigation: Introduction to geotechnical engineering. Seismic Cone Penetrometer Test, Cone Penetration Test, Standard Penetration Test, Cyclic Stress Ratio, Cyclic Resistance Ratio, estimation of blow count 'N' of SPT from Shear Wave. Multichannel Analysis of Surface Wave, land energy sources for seismic refraction study, basic theory and working principle of seismic transducers, Geometry of refraction ray path and time distance relationships.

Seismology: Phenomena of earthquake and its effects. Elastic rebound theory. Intra and inter plate earthquakes, classification of earthquakes. Monitoring rockmass performance: purpose and nature; Monitoring systems including seismic and microseismic methods. Magnitude and intensity scales, impacts and assessment of earthquakes and related hazard, risk and their mitigation. Different types of elastic waves and their propagation characteristics, Attenuation and dispersion of seismic waves. Strong motion seismology: displacement, velocity and acceleration response spectra, Seismic damping, Strong motion instrument. Ray characteristics and related parameters for horizontally and spherically stratified earth. Fault plane solutions and related interpretation, moment tensors for different fault patterns, earthquake characteristics along constructive, conservative and destructive boundaries. Seismic networks and arrays, stand-alone and telemetry systems. Earthquake prediction: dilatancy theory, short-term, middle-term and long-term prediction

Resistivity Method: True and apparent resistivity, resistivities of common rocks and minerals. Fundamental relationship between potential and apparent resistivity. Electrode configurations—Schlumberger and Wenner, Vertical Electrical Sounding, Interpretation of two layered VES curves.

Signal Analysis: Signals, noise and their classification, continuous and discrete signals. Fourier analysis of signal, Fourier transform and its properties, energy and phase spectra.

Geology: Different types of rocks and soils. Design and stability of structures in rock: Intact rock and rock-mass classification systems. Methods for design and stability analysis, Design of single and multiple openings in massive, stratified and jointed rock mass. Subsidence: Causes and impacts of subsidence; Mechanics of surface subsidence, discontinuous and continuous subsidence; Monitoring, prediction, control and management of subsidence. Evolution of different land forms. Applications of geomorphology in different geological investigations. Shallow-level drilling and related technology. Engineering properties of rocks and soils. Geotechnical investigations for dams, reservoirs, tunnels and mass movements. Characteristics of different aquifer. Groundwater flow. Groundwater development. Introduction to principles and applications of remote sensing.

Environmental Science: Air pollution, water pollution, water quality parameters. Green house effects, major green house gases; potential impacts of global warming; stratospheric ozone layer depletion and its causes; acid rain and its impacts.

Name of subject: Petroleum Exploration **Code: PEX**

PART 1 : GEOPHYSICS

Solid Earth Geophysics: Earth: its rotation and figure. Gravity and its variation over the earth, Earth: surface features, continents, continental margins, oceans. Thermal history and its characteristics over various earth surface features.. Earth's interior: physics status; variation of physical quantities and seismic wave velocity inside the earth, major sub divisions. Composition and structure of upper and lower continental crust, layering in oceanic crust, crustal structure studies for mountains, plateau, basins in India, Gravity and DSS studies for the Himalayas. Oceanic magnetic anomalies and their interpretations, magneto stratigraphic time scale, paleomagnetic evidences from continental drift, APWP for different continents-their main results, seismological evidences for lithospheric deformation, concept of sea floor spreading and plate tectonics, plate margins and processes at plate margins, triple junction, Characteristic movement of Indian plate and formation of the Himalayas.

Seismology: Elastic rebound theory, causes of intra and inter plate earthquakes, classification of earthquakes, Determination of Earthquake parameter. Seismicity and Seismotectonics of India & Himalaya, Frequency- Magnitude (b value), Velocity Structure and V_p/V_s study.

Signal Analysis: Signals, noise and their classification, continuous and discrete signals. Complex exponential Fourier series, Fourier integral, Fourier transform and its properties, energy and phase spectra, Fourier transforms of some commonly used functions, utility of domain transformation; inverse Fourier transform; use of one and two dimensional Fourier transforms in solving geophysical problems, radial and angular spectra.

Exploration Seismology: Travel time relation for direct, reflected and head waves over multi layered earth. Land and marine energy sources, electromagnetic pulse and Accelerated Weight Drop. Basic theory and working principle of seismic transducers, Various refraction/transmission shooting techniques: reduction of refraction data. Seismic attenuation, reflection and transmission coefficients, Knott and Zoeppritz equations. Geometry of reflection ray path and time distance relationship, seismic noise and their cause. Methodology for 2D reflection Survey: Different kinds of spread geometries, end on, slit spread, crooked lined profiling, linear and tapered geophone arrays, effect of arrays on the seismic response, optimization of spread geometry, offset matching, source arrays. Common depth point shooting and its advantages. 3D survey designing: Different 3D geometries, swath, MESA, GEOLAND, GX-III, 3D survey design shootings- in line, slant and orthogonal, optimization of source and receiver lines in a swath, optimization of different offsets. Offshore survey: Single, streamer and multiple streamer.

Processing sequences- preparation of processing geometry, quality checks, true amplitude recovery, deconvolution, filtering, velocity analysis, statics, noise elimination through multichannel filtering, parameter optimization for generation final stacked section. DMO and migration, AVO and attribute analysis. Anisotropy processing: HTI, VTI .Mode .Converted Wave Processing.3D Processing techniques- generation of time slice and stacked sections.

Resistivity and IP methods: Fundamental relation between potential, apparent resistivity, resistivity transform and layer distribution of a stratified earth. Applications of linear filter theory; determination of filter coefficients, sinc response —filter length. Potential due to a point source in an anisotropic

medium, triangle of anisotropy. Partial curve matching of three layer and four layer curves, Dar Zarrouk parameters, principle of equivalence, Resistivity modeling. Mise-a-la-masse method.
Sources of IP, membrane and electrode polarizations, time domain and frequency domain measurement of IP, chargeability, percent frequency effect and metal factors, apparent chargeability over layered earth, electromagnetic coupling.

Electromagnetic Method: Principle of electromagnetic induction; magnetic field due to a current carrying loop, elliptical polarization, plane of polarization, dip and tilt angles, nomograms for quantitative determination of parameters by dip angle method, VLF and AFMAG methods, TURAM method.
Response of a single closed conducting circuit by using a fixed horizontal transmitter-receiver system. Analysis of response function with frequency and different ranges of conductivities, amplitude and phase relations, vector diagrams and their significance. Maxwell's equations, propagation of electrical and magnetic field as a dissipative wave, diffusion equation, propagation constant
Gravity and Magnetic method: A review of land gravimetry; gravity measurements in sea, reduction of data and interpretation of Bouger anomaly maps; ambiguity in gravity interpretation and conditions for unique interpretation; use of gravity survey in mineral and hydrocarbon exploration programs, search for metallic and nonmetallic ores, coal and lignite; mapping faults, exploring for salt domes, stratigraphic traps, uplifted horst and graben, use of gravity in regional geological studies including granitic plutons, thrust belts, accreted terrains.

Measurement of earth's magnetic field and its gradient from air and sea, instrument mounting and stability of platforms, reduction of data, preparation and interpretation of anomaly maps, Interpretation of aeromagnetic maps. Utility of aeromagnetic maps in mineral and hydrocarbon exploration programs and regional studies.

Remote Sensing and Image Processing: Sources of EMR and governing laws; interaction of EMR with atmosphere and surface of the earth. Atmospheric windows; spectral signature and spectral reflectance, spectral responses of vegetation, water, soil etc. Types of sensors- photographic, single and multi band opto mechanical, thermal sensors, LISS and sensor array: their principle and operations; spectro-radiometers, microwave sensors: SLAR and SAR Systems.
Structure of Remote Sensing Images, Data format BIL, BSQ and BIP, type of data products. Image Processing technique as applied to satellite image data. Image restoration, reduction, magnification ,contrast enhancement (linear and non linear), histogram equalization, rationing, filtering and edge enhancement.

Well logging: Borehole environment, Logging tools: Basic principles, calibration, environment corrections, computation of reservoir parameters and their simple applications:
Resistivity: focused (SFL), micro resistivity devices, conventional induction logging tools.
Self potential: electrical analogue of SP, effects of bed thickness, hole diameter, shaliness, irregular invasion on SP response. SP in tight formations, bimetallism and bimagnetism effects on SP.
Natural gamma ray: Effects of borehole environment, logging speed, time constant and formation density on log response, corrections for caving and casing etc.; measurement of porosity using neutron sources: CNL, SNP; compensated density and sonic tools for porosity measurements.

PART 2 : GEOLOGY

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Name of subject: Chemical Engineering Code: CHE

Fluid Mechanics: Fluid statics; fundamental concepts of fluid flow, Newtonian and non-Newtonian fluids, incompressible and compressible fluid flow, Bernoulli's equation, macroscopic friction factors, transportation and metering of fluids, pump characteristics.

Chemical Process Calculation: Steady-state and dynamic processes, lumped and distributed processes, single and multi-phase systems; equilibrium relations, correlations for physical and transport properties, behaviour of ideal and real gases and gaseous mixtures, vapor pressure, humidity and saturation, mass and energy balance with and without recycle, bypass and purge, heat of reaction and laws of thermochemistry; combustion calculations.

Heat transfer: Basic modes of heat transfer, heat transfer coefficients, boiling, condensation and evaporation, and their applications, types of heat exchangers and evaporators .

Mechanical Operations: Types of mechanical operations, characteristics of particulate solids: sampling techniques, specification and screen analysis, particle size distribution; principles of size reduction, crushing and grinding efficiency, laws of crushing, theory and applications of filtration.

Chemical Engineering Thermodynamics: Basic concepts of thermodynamics, extensive and intensive properties, state and path functions, laws of thermodynamics and their applications, equation of state, thermodynamic properties of fluids, vapour-liquid equilibria, chemical reaction equilibria.

Mass Transfer: Fundamentals of mass transfer: molecular diffusion, mass transfer coefficients and interface mass transfer, steady and unsteady state theories of mass transfer, heat and mass transfer analogies, single and multi-stage contact operations, distillation, absorption and stripping, humidification, drying, liquid–liquid extraction, leaching, adsorption.

Chemical Reaction Engineering: Theories of reaction rates, kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal and non-ideal reactors, residence time distribution, single parameter models, non-isothermal reactors, diffusion effects in catalysis, Kinetics of Biochemical & polymerisation reactions.

Instrumentation and Process Control: Measurement of process variables, sensors, transducers and their dynamics, transfer functions and dynamic responses of simple systems, feedback controllers, analysis of closed loop control systems including stability.

General Chemical Technology: Inorganic and organic process industries, sulphuric acid, sodium hydroxide fertilizers (ammonia, urea, phosphatic fertilizers), pulp and paper, sugar, oil and fats industries, petroleum refining and petrochemicals, polymerization industries, polyethylene, polypropylene, PVC and polyester synthetic fibres.

Fuel & Energy: Solid, liquid and gaseous fuel; and their utilisation, renewable energy sources.

Name of subject: **Structural Engineering** **Code:** **STE**

Mechanics: Bending moment and shear force in statically determinate beams. Simple stress and strain relationship: Stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle. Simple bending theory, flexural and shear stresses, unsymmetrical bending, shear centre. Thin walled pressure vessels, uniform torsion, buckling of column, combined and direct bending stresses.

Structural Analysis: Analysis of statically determinate trusses, arches, beams, cables and frames, displacements in statically determinate structures and analysis of statically indeterminate structures by force/ energy methods, analysis by displacement methods (slope deflection and moment distribution methods), influence lines for determinate and indeterminate structures. Basic concepts of matrix methods of structural analysis.

Concrete Structures: Concrete Technology- properties of concrete, basics of mix design. Concrete design- basic working stress and limit state design concepts, analysis of ultimate load capacity and design of members subjected to flexure, shear, compression and torsion by limit state methods. Basic elements of prestressed concrete, analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam- columns, column bases. Connections : simple and eccentric, beam–column connections, plate girders and trusses. Plastic analysis of beams and frames.

Soil Mechanics: Origin of soils, soil classification, three-phase system, fundamental definitions, relationship and interrelationships, permeability & seepage, effective stress principle, consolidation, compaction, shear strength.

Foundation Engineering: Sub-surface investigations: scope, drilling bore holes, sampling, penetration tests, plate load test. Earth pressure theories, effect of water table, layered soils. Stability of slopes: infinite slopes, finite slopes. Foundation types, foundation design requirements. Shallow foundations: bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands & clays. Deep foundations: pile types, dynamic &static formulae, load capacity of piles in sands &clays, negative skin friction.

Fluid Mechanics and Hydraulics: Properties of fluids, principle of conservation of mass, momentum, energy and corresponding equations, potential flow, applications of momentum and Bernoulli's equation, laminar and turbulent flow, flow in pipes, pipe networks. Concept of boundary layer and its growth. Uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies, flow measurements in channels, tanks and pipes. Dimensional analysis and hydraulic modeling.

Water supply and waste water treatment: Basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of waste water. Primary, secondary and tertiary treatment of wastewater, sludge disposal, effluent discharge standards.

Highway Engineering: Geometric design of highways, testing and specifications of paving materials, design of flexible and rigid pavements.

Name of subject: Computer Science and Engineering Code: CSE

Discrete Mathematics: Combinatorics, algebraic structures, mathematical logic, Boolean algebra, recurrence relation, generating functions.

Probability & Statistics: Conditional Probability, Random Variables and distribution, Least squares, correlation and regression.

Data Structures: Arrays, stacks, queues, linked lists, binary trees, binary search trees, AVL trtees, 2-3 trees, B-trees, graphs, hashing, sorting and searching.

Algorithm Design and Analysis: Performance analysis of algorithms, divide and conquer, greedy algorithms, dynamic programming.

Digital Circuits and Computer Organization: Logic gates, combinational and sequential circuits, registers and counters, data representations, CPU design, instruction set, Input/output organization, memory organization, computer arithmetic.

Theory of Computation: Finite automata, regular expression, context free grammar, push down automata.

Operating Systems: OS structure, process management, memory management, I/O management.

Computer Networks: Physical layer, data link layer, network layer, transport layer, Emailing, www, wireless LAN and Adhoc Networks.

Database Management Systems: Database design, data storage and querying, transaction management.

Name of subject: Electrical Engineering Code: ELE

1. Electric Circuits and Fields: Network graph, KCL, KVL, node and mesh analysis, transient response of dc and ac networks; sinusoidal steady-state analysis, resonance, basic filter concepts; ideal current and voltage sources, Thevenin's, Norton's and Superposition and Maximum Power Transfer theorems, two-port networks, three phase circuits; Gauss Theorem, electric field and potential due to point, line, plane and spherical charge distributions; Ampere's and Biot-Savart's laws; inductance; dielectrics; capacitance.
2. Signals and Systems: Representation of continuous and discrete-time signals; shifting and scaling operation; linear, time-invariant and causal systems; Fourier series representation of continuous periodic signals; sampling theorem; Fourier, Laplace and Z transforms.
3. Electrical Machines: Armature reaction and communication, three phase induction motors-principle, starting and speed control, types, performance characteristic, single phase induction motors, regulation and parallel operation of generators, synchronous machines-performance, servo and stepper motors, regulation and parallel operation of generators, motor starting, single phase transformer-equivalent circuit, tests, phasor diagram, regulation and efficiency, parallel operation, three phase transformers connections, windings, generator characteristics, auto-transformer, energy conversion principles, DC machine-types.
4. Power Systems: Basic power generation concepts; transmission line models and performance; cable performance, insulation; corona and radio interference; distribution systems; per-unit quantities; bus impedance and admittance matrices; load flow; voltage control; power factor correction; economic operation; symmetrical components; fault analysis; principles of over-current, differential and distance protection; solid state relays and digital protection; circuit breakers; system stability concepts, swing curves and equal area criterion; HVDC transmission and FACTS concepts.
5. Control Systems: Principles of feedback; transfer function; block diagram; steady-state errors; Routh and Niquist techniques; Bode plots; root loci; lag, lead and lead-lag compensation; state space model; state transition matrix, controllability and observability.
6. Power Electronics and Drives: Thyristor, Static characteristics, Triggering circuits, bridge converters-fully controlled and half controlled, phase control rectifiers, principle of choppers and inverters, semiconductor power diodes, basic concepts of adjustable speed AC and DC Drivers.
7. Electrical and Electronic Measurements: Energy and power factors, digital voltmeters and multimeters, instrument transformers, time, phase and frequency measurement, oscilloscopes, potentiometric recorders, Q-meters, error analysis, bridges and potentiometers, moving iron, PMMC, dynamometer and induction type instruments, power, current, measurement of voltage.
8. Analog and Digital Electronics: Characteristics of diodes, BJT, FET;Amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers – characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits; multiplexer; Schmitt trigger; multi-vibrators; sample and hold circuits; A/D and D/A converters; 8-bit microprocessor basics, architecture, programming and interfacing.

Name of subject: Electronics & Communication Engineering Code: ECE

1. **Semiconductor Devices:** Band structure of semiconductors, current transport in semiconductor, p-n junction, I-V, C-V characteristics of p-n junction diode, Schottky diode, tunnel diode and their characteristics, BJTs, JFETs and MOSFETs - operations and their characteristics.

2. **Analog Circuits**: Biasing of transistors and FETs; Amplifiers : single and multi-stage, feedback, differential, operational (OP-AMP), wideband, tuned, power; Oscillators: RC, LC, crystal, relaxation, Wein Bridge; Function generators and wave-shaping circuits; Power supplies.

3. **Digital Electronics**: Number systems and Boolean Algebra, Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders; Sequential circuits: latches and flip-flops, counters and shift-registers; comparators; timers; ADCs and DACs; Semiconductor memories; Microprocessor(8085): architecture, programming, memory and I/O interfacing - interfacing with 8155, 8255, 8253, 8259, 8251, 8279 and A/D and D/A converters.

4. **Instrumentation and Measurements**: Principle of measurements and error analysis. Instruments: DC & AC voltage and current meters, power and energy meters, meter for measuring speed, potentiometer and bridges; estimation of instrument ranges. Amplifiers in instrumentation, Digital display in instruments. Principle of oscilloscope and recorders, Passive (resistive, inductive, capacitive) and active (thermoelectric, piezoelectric, photoelectric etc.) transducers.

5. **Network Theory**: Network theorems, Graph theory and network equations, Solution methods: nodal and mesh analysis, Two-port network parameters, Driving point and transfer functions, Application of Laplace transform to Electric networks, Introduction to filters, Butterworth and Chebyshev approximations.

6. **Signals and Systems:** Continuous and discrete-time signals, Systems described by differential and difference equations, Convolution, Linear time invariant systems: Impulse response, Properties: causality, stability, invertibility; Fourier series and Fourier transform of continuous and discrete-time signals, Laplace and Z transform and their application in signal analysis.

7. **Control Systems**: Transfer functions; block diagram reduction techniques; signal flow graphs; basic control components; transient and steady-state response analysis; stability of linear systems, Routh-Hurwitz criterion, Root-loci; frequency response; Nyquist criterion; Bode plot, Nichols chart, PID control; compensation techniques.

8. **Communication System**: Spectral analysis and signal transmission through linear time invariant systems; random process and Noise; correlation and power spectrum; A.M. F.M. and P.M. - modulation and demodulation systems, their performance in presence of noise; sampling theorem; pulse code modulation(PCM), Differential Pulse Code Modulation (DPCM), Delta Modulation (DM); digital modulation systems : amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwidth consideration and probability of error calculations

for these schemes.; FDM and TDM; Fiber Optic Communication System, Optical Sources, Detectors, Solar Cells.

9. **Electromagnetic Theory:** Maxwell's Equations in differential and integral Forms; Boundary Conditions - Dielectric-Dielectric and Dielectric-Conductor Interfaces; Uniform Plane Waves - Wave propagation in lossless and conducting media; Poynting Vector and Poynting Theorem; Waveguides - planar, rectangular and circular; TE, TM, TEM Modes - concepts and analysis, cut-off frequencies, velocities, wavelengths, wave Impedances, attenuations factor; Transmission Line - Transmission Line Equations, Characteristic Impedance, Propagation Constant, Phase and Group Velocities, Infinite Line, lossy, lossless and distortionless line; Reflection Coefficient and VSWR; Impedance matching – impedance transformer & single stub, Antennas - Dipole antennas, antenna arrays, different antenna parameters.

Name of subject: Environmental Science & Engineering Code: ESE

General ecology : Ecology & ecosystem, food chain, biomagnifications; energy flow, ecological pyramids; biogeochemical cycles, biodiversity conservation, hot spots.

Air pollution: Green house effects, major green house gases; potential Impacts of global warming; stratospheric ozone layer depletion and its causes; Acid rain and its Impacts.

Primary and secondary air pollutants; photochemical smog. Vehicular emissions: EURO-II, EURO-III and EURO-IV. Air pollution standards. Air pollution control – particulates and gaseous.

Noise pollution, Propagation of noise; Control measures.

Water pollution: Water quality parameters and their environmental significance. Coagulation and flocculation; disinfections; water softening.

Environmental legislation: Different Acts/Regulations related to the control and abatement of environmental pollution in India.

Environmental Impact assessment (EIA); Environmental audit; EMS and ISO 14000 series.

Name of subject: Fuel Engineering **Code: FLE**

Momentum, Heat and Mass Transfer, Combustion, Conventional & Non-conventional Sources of energy, Fossil fuels & their characteristics, Unit operations- size reduction, size separation, concentration, mixing, solid-liquid separation.

Theory of machines, fluid mechanics, mechanics of solids, material handling, fluid flow machines, strength of materials, electrical technology, Mechanical testing of materials.

General principles of metallurgy, Alloys, Phase diagrams, Extraction of non-ferrous metals like Pb, Zn, Cu, gold etc., Iron making, Steel making, Mechanical properties of metals.

Definition and important terminology, Liberation, Size reduction and separation, Screening and Classification, Principles of concentration processes, Dewatering & drying.

Mining methods, environmental aspects of mining, Mine gases, dust & explosion, waste disposal.

Name of subject: Mineral Engineering **Code: MLE**

Scope and importance of Mineral Engineering, definition of ore, mineral, gangue etc. Basic unit operations involved in mineral processing operations, relative merits and demerits of processing of ores. Fundamentals of size reduction, purpose, liberation of minerals, degree of liberation.

Different types of crushers and grinding mills, their features and usages. Introduction to various size separation processes. Movement of solids in fluid. Hindered settling, free settling, equal settling particles. Reynolds number and its importance. Types of classifiers used in mineral engineering and their principles

Principles and practices of different types of concentration processes used in mineral beneficiation such as gravity concentration, magnetic separation, flotation etc.

Fundamentals of sintering, pelletization, dewatering & drying.

General principles of extractive metallurgy. Extraction of metals such as Pb, Zn, Cu, Au, Al, Ti. Basic principles of Iron making and Steel making,

Name of subject: Industrial Engg. & Management Code: IEM

1. **Principles and Practices of Management:** Management: concept and basic features, Functions of Management: Planning, Organizing, Staffing, Directing, and Controlling, Organization structure, Basic theories of Management.

2. **Human Resource Management:** Training and Development, Motivation, Recruitment and Selection.

3. **Quantitative Techniques;** Role of quantitative techniques in managerial decision making, Linear Programming: Features, Modeling, Simplex method of solution, Transportation model and Assignment problem.

4. **Industrial Engineering:** Concept and measurement of Productivity, Work Study techniques, Inventory Management: ABC analysis and EOQ model

5. **Project Management:** Concept of a Project, Project Scheduling: time estimates, CPM/PERT

6. **Financial Management:** Break-even analysis, Time value of money, Capital Budgeting decisions.

Name of subject: Mechanical Engineering Code: MEC

Engineering Mechanics: Static and dynamic equilibrium of rigid bodies, Analysis of structures: Trussses, Frames and Machines, Distributed forces: Centroids, Centers of gravity & Moments of Inertia, Method of virtual work, Kinematics and kinetics of particles and rigid bodies.

Mechanics of Solids: Complex stress and strains combined bending and axial torsion, Shear force and bending moment diagrams. Deflection of beams, fixed and continuous.Thick and thin cylinders, columns, springs.

Theory of Machines : Velocity & acceleration diagrams of linkages,CAMs, Fly wheel, governors, gear profile and gear trains, Gyroscope, Friction, Belt drive, Brakes, Clutches, Dynamometers balancing and vibrations.

Machine design: Engineering and computer graphics, basic concepts of design, Engineering materials, CAD, Cotter and Knuckle joints, bolted, riveted and welded joints,Screw Jack, design of mechanical component i.e. shaft, coupling, pulleys, gears, bearings.

Thermal engineering: Laws of thermodynamics, entropy, enthalpy, internal combustion engines, boilers, steam turbine, mode of heat transfer, heat exchangers, refrigeration, cycles and air conditioning.

Fluid Mechanics and Fluid Machines: Properties of fluid, Bernoulli's equation, Euler's equation, Reynolds's equation,Navier Stoke's equation flow of fluid, reciprocating and centrifugal pumps, hydraulic turbines.

Production Technology: Metal cutting, metal forming, and welding, conventional and non-conventional machining methods: EDM, Wire EDM, USM, LBM, PAM, ECM. Computer Aided Manufacturing: NC, DNC, CNC, CIM, FMS, AGV, Automation & Robotics, CPM and PERT.

Name of subject: Geomatics **Code: GEM**

Chain surveying, Levelling, Traversing, tacheometry and Plane Table Surveying. Construction and use of Theodolites, levels, Tacheometer and Plane Table. Contours and Contouring. Area and volume calculations.

Name of subject: Mining Engineering **Code: MIN**

ROCK BREAKING

Drilling: for production of minerals from surface and underground mines; Rotary, percussive and rotary-percussive drilling; Short and long hole drilling and drilling equipment; Mechanism of drilling; Different types of bits; Bit wear; Drilling; in difficult formations; Drilling patterns for primary and secondary development and stoping; Drillability of rocks; Drilling performance and costs.

Explosives: Types of explosives – their composition and properties; Selection of explosives; Manufacture, transport, storage and handling of explosives; Testing; of explosives;

Blasting: Mechanism of rock breakage and facture; Mechanics of rock fragmentation by explosive action; Blasting techniques; Blasting accessories exploders; Design of blasting rounds for opencast and underground mines; Computational models of blasting; Transient ground motion; Misfires, blownout shots, incomplete detonation – their causes and remedial measures; Controlled blasting techniques; Perimeter blasting; Safety precautions; Ground and air vibrations from blasting, damage and control; Instrumentation in blasting – borehole pressure transducer, V.O.D. probe, vibration monitor, high speed video camera; Impact of ground vibration and sound on the neighbouring structures and communities, and mitigative measures; Alternative methods of rock fragmentation.

ROCK SUPPORT AND REINFORCEMENT

Terminology, support and reinforcement principles and design; Pressure arch theory; classification of mine supports; Computation of support requirement under different conditions.

Timber support: drift-set of various types, square-set, crib-set, cog, stull and chock/chockmat supports; Forepoling/spiling; Load bearing capacity of timber supports; Bulkheads.

Steel support: Steel set- rigid and yielding types; Tubbing, wire mesh, steel lining, screw jacks and ratchet jacks; Improvised steel props, friction props, hydraulic props; Link bars and chocks, powered supports; Safari support.

Cement support: Powered monolithic and reinforced concrete lining; Monolithic packing in longwall advancing gate roads, concrete blocks, concrete slabs, guniting and shotcreting.

Rock support: Pillars of ore and waste, pack walls, masonry walls ;and arches- building materials and construction.

Full support: Materials of backfill and their procurement; Sand gathering plant; Theoritical aspects of slurry transportation; Preparation, transport and placement of hydraulic backfill with and without cement; Rock and concrete fills; Surface arrangement for storage and mixing; Pneumatic and mechanical methods of backfilling.

Re-inforcement materials and techniques; Rock bolts and dowels-different types and uses; mechanics of bolting.

Anchored rockbolts: Solt and wedge, expansion shell and grouted point anchor type.

Full column anchors: Wooden ;and fibreglass dowels, mechanical full column anchors, split sets/friction rock stabilizers, swellex, full column grouted rockbolts.

Installation and testing of rock bolts.

Cable bolting: Installation and applications.

Ground stabilization: Ground dewatering, ground cementation, ground freezing and ground de-stressing.
Open pit ground control.

ROCK MECHANICS

Design and stability of structures in rock: Intact rock and rock mess classification systems; Methods for design and stability analysis of underground excavations; Energy released by making an underground excavation; Design of single ;and multiple openings in massive, stratified and jointed rock mass; Mine pillars and their classification, pillar stresses, pillar design, stability analysis of pillars; Design of protective pillar.
Design of support and reinforcement for underground excavation: Types & classification of support and reinforcement systems; Support and reinforcement requirement-influencing parameters, estimation and selection; Support and reinforcement principle; Method of design.
Subsidence: Causes and impacts of subsidence; Mechanics of surface subsidence, discontinuous and continuous subsidence; Monitoring, prediction, control and management of subsidence.
Caving of rockmass: Rock caving in mining; Mechanics of rock caving; Assessment of cavability.
Rockburst: Phenomenology of rockbursts; Prediction and control of rockbrusts; Bumps and gas outbursts.

Introduction to numerical methods; of mine Design: Predictive; methods for mine design; Principles of classical stress analysis- closed form solutions for simple excavation shapes; Introduction to computational methods of stress analysis – finite element, boundary element, distinct element methods and hybrid computational scchemems.
Monitoring rockmass performance: Purpose and nature; Monitoring systems including seismic and microseismic methods.
Mechanics of fragmentation: Mechanism of rock cutting by picks, disc and roller-cutters; Mechanics of rock drilling; Water-jet cutting; Mechanics of blasting; Methods of assessing cuttability, drillability and blastability of rocks.
Slope stability in surface mines: Type of mine slope; Influence of pit slope on mine economics; Common modes of slope failure; Factors influencing slope stability; Slope stability; Protection and monitoring of slopes; Waste dumps - types and formation methods; Stability analysis and design; Stabilisation measures and monitoring.
Basic concepts of surface mining; Role of surface mining in total mineral production; Deposits amenable to surface4 mining vis-a-vis excavation characteristics; Surface mining unit operations; Surface mining systems vis-a-vis equipment systems – classification, applicability, advantages and disadvantages.
Stage/Phases of mine life; Preliminary evaluation of surface mining prospects; stripping **ratios-** concepts and significances.

SURFACE MINING METHODS

Box cut – objective, types, parameters, methods; Factors affecting selection of site; Production benches – formation, parameters and factors affecting their selection.

Ripping – working principle of ripper, ripper types, cycle of operation, concept of rippability, applicability and limitations of ripping; Drilling – types of blasthole drills; Performance parameters of drills; Estimation of number of drills required for a given mine production; Blasting – blast design, determination of charge weight (base charge), factors influencing blast design; Calculation of charge required per hole; Secondary blasting; Problems of; blasting.
Shovel-dumper operation – applicability and limitations of electric shovel, hydraulic excavators and dumpers; Method of work for sub-surface bedded and massive deposits and hilly massive deposits; Cycle time and productivity calculation for shovel dumper; Estimation for equipment (shovel, dumper and other heavy earth moving machines) required for a given mine production.
Dragline operation – applicability and limitations; Methods of work by simple side casting; Side cast diagram and calculation of reach; Cycle time and productivity calculation; Calculation of required bucket capacity for a given handling requirement; Maximum usefulness factor and its significance.
Scrapers – applicability and limitations, various types; Method of work; and cycle ;of operations; Pusher dozer and push-pull operation.
Dozers –applicability and limitations; Method of work and cycle of operations; Types of blade and corresponding merits and demerits.
Front-end-loaders – applicability and limitations; Cycle of operations; Minimum tipping-load – concept, estimation and significance, calculation of maximum working load and bucket capacity for a given job condition.
Bucket wheel excavators: applicability and limitations; Types ;and principle of operation; Operational methods – lateral block/ half block method, full block methods and their corresponding merits and demerits; Calculation of productivity.
Continuous surface miner; Types and principles of operation; Operational methods – classification; Wide/full bench method, block mining method and stepped cut method; Empty travel back method, turn back method and continuous; mining method; Conveyor loading and windrowing method, merits and demerits; Applicability; and limitations of surface miners.
Conveyors: Shiftable and high angle conveyors; Mode of operation, applicability and limitations; Merits and demerits of conveyor as a system of transportation.
Introduction to mining of dimensional stones: Occurrence; Winning methods and equipment; Processing and applications.

UNDERGROUND COAL MINING METHODS

Opening of coal seams: Legal requirements about outlets, vertical shaft versus incline; Choice of methods of mining coal seams, factors affecting choice of mining methods.
Bord and Pillar mining: General principles of Bord and Pillar (B&P) development, different schemes and associated merits/ demerits; Design of B&P workings, statutory provisions, manual and mechanised schemes of development; Conditions suitable for application of mechanised loaders ;and continuous miners; Factors affecting selection of equipment.
Pillar extraction: Preparatory arrangement for depillaring operation, statutory provisions on depillaring; Principles of designing pillar extraction, factors affecting choice of pillar extraction; Depillaring with caving/stowing; Mechanisation in depillaring operation.

Local and main fall, indications of roof weighting, measures to bring down roof at regular interval; Air blast and precautions to minimize its effects; Precautions during depillaring operation against fire ;and inundation; Multi-section and contiguous workings.
Longwall mining: Factors affecting lonwall mining, longwall face layouts, advancing vaersus, retreating faces, single versus double unit longwall faces, orientation of longwall faces' Factors affecting length and width of longwall panel.
Shape and size of development roadways, methods of driving gate roads, single versus multiple heading gate roads.
Extraction of longwall panel: Working with shearer ;and plough; Support system of longwall face and gate roads; Case studies of longwall faces in India.
Mining of thick seams: Concept of a thick seam; Problems of mining thick seams; Past experience of working thick seams by Board & Pillar method ;in multi-sections; Modern mullti-slice methods – inclined slicing, horizontal slicing and cross-slicing in ascending and descending sequence; Underwinning methods – sub-level caving, integral caving, blasting gallery method, descending shield method and hydraulic mining .
Mining of thin seams: Problems in mining thin seams; Equipment and methods for thin seam extraction.
Underground coal gasification: Basic principle; Methods of gasification; Scope of application.

UNDERGROUND METAL MINING METHODS
Development: Choice of level interval and back/block length; Shape, size, position excavation and equipping of shaft station/plat, grizzly, ore/waste bin, main orepass system, underground crushing and loading stations, underground chambers, sump and other subsidiary excavations; Arrangements for dumping into main prepass; Underground crushing, loading and hoisting.
Cross-cuts and drifts – their shape, size and position; Review ;of excavation process – ground breaking, mucking, ventilation and support; Track extension and car switching; Use of modern drilling and loading equipment in drifting; Raises and winzes – their shape, size and position; Excavation process – ground breaking, mucking, ventilation and support; Modern methods of raising – Alimak and Jora-lift raising, longhole method including vertical crater retreat method of raising; Raise boring – systems and their details; Modern methods of winzing; Secondary breaking at grizzley – conventional and mechanised methods.
Stoping: Selection of stoping methods; Classification of stoping methods; Stoping of narrow ore bodies by underhand, overhand, breast, longhole and raise mining methods Resuing; Mining of parallel veins; Room & pillar, sublevel, large diameter; lblast hole/DTH, cascade, shrinkage and vertical crater retreat methods – their applicability, stope layouts, stope preparation, ground breaking, mucking , ventilation and supporting; Haulage and dumping; Supported; methods – horizontal overhand and underhand cut-and-fill methods, square-set method and its variations, details of stope layouts, ground breaking, supporting, mucking, ventilation, haulage and dumping.
Caving methods: Top slicing, sub-level caving ;and ;block caving methods; stope layouts, stope preparation and production operations; Design and construction of draw points; Mechanics of draw and draw control procedure; Recovery and dilution.
Combined systems: Combined open-room, shrinkage, and cut-and-fill systems; Combined systems with subsequent; filling of rooms.

Deep mining: Problems of deep mining and their remedial measures; Design and layout of stopes in rockburst prone mines.
Special methods: Hydraulic, thermal, hydrochemical and biochemical methods; Nuclear device mining system – scope of application for mining of deep seated low grade mineral deposits; Underwater/sea-bed mining - current status; Different methods of winning manganese nodules from the ;ocean-floor.

MINE PLANNING
Mine planning and its components; Role of planning in mining ventures; Ore reserve estimation, economic block model.
Mine planning inputs – geological, mineralogical, structural, economic, environmental and technical inputs.
Mine size – optimal geometrical mine size, optimisation of mine size (mine production capacity) based on economic considerations; Taylor's mine life rule; Ultimate pit configuration.
Mine system and sub-systems.
Equipment and face scheduling against targeted production.
Mine closure – ongoing and final.
Feasibility report and project report – contents and preparation.

Name of subject: Tunnelling & Underground Space Technology **Code: TUT**

Natural caves, archeological caves and their construction, tunnels for road, rail and hydropower, need for underground space, engineering utilities such as hydropower tunnels and caverns, underground storage for LPG and crude oil , geo-engineering investigations, physico-mechanical properties of rocks, subsurface investigations, planning and design aspects of underground excavations, tunneling methods, instrumentation, various supports used for tunnels, caverns and their design approaches. Engineering geological aspects, Mining and Civil engineering aspects are given importance.

Name of subject: Mining Machinery Engineering Code: MME

Shear forces, bending moments, stresses and deflection in beams and cantilevers; Torsion of shafts; Principal stresses and strains; Pressurized cylinders and spheres; Columns and struts.

Machines, links and mechanisms, Brakes; Dynamometers; Governors; Cams; Gears and gear trains; Gyroscopic motions; Balancing; Vibrations.

Fluid statics, kinematics and dynamics; Different types of flow as applicable to fluid mechanics; Dimensionless numbers; Hydraulic turbines and pumps; Hydraulic systems.

Engineering thermodynamics; different processes, cycles; Performance and power calculations of different I.C.Engines and turbo-machines; different heat transfer processes; Dimensionless numbers; Refrigeration cycles and COP.

Steel wire ropes; Power Hydraulics; Belt conveyors; Mine Winders; Shovels; Draglines; Dumpers; Power supports; Shearers; Plow; Road headers; Dint header; Continuous miners; Surface miner; Dewatering pumps; Ventilation fans; Compressors; Rock drills used in underground and open-pit mines; Crushers; Dozers; Chain conveyors.

Name of subject: Petroleum Engineering **Code: PET**

Fundamental of Petroleum Engineering: Thermodynamic properties of gas, oil, and waters: Phase behavior of hydrocarbon systems ideal and non-ideal gases and liquid systems; qualitative and quantitative phase behavior. Basic principles and characteristics of petroleum reservoirs.

Oil and Gas Well Drilling Technology: Well planning. Drilling method. Drilling rigs and operation. Drilling fluids. Oil & gas well cementing operations. Drill bit, Drill string & Casing string function, operations, selection & design, Directional drilling, Application of horizontal, multilateral, extended reach, slim wells.

Reservoir Engineering: Petro-physical properties of reservoir rocks. Coring and core analysis. Reservoir fluid properties. Flow of fluids through porous media. Water and gas coning. Reservoir pressure measurements. Reservoir drives, drive mechanics and recovery factors. Reserve estimation & techniques.

Petroleum Production Operations: Well Equipments, Well Completion Design, Production System Analysis & Optimization, Well Production Problems and mitigation, Designing Gravel Pack for Sand Control, Well Servicing & Workover, Artificial Lift Techniques.

Offshore Drilling and Production Practices: Offshore oil and gas well Drilling Operations, Offshore well completion. Deep water applications of subsea technology. Offshore production: Oil processing platforms, water injection platforms, storage, SPM and SBM transportation and utilities.

Well Test Analysis and EOR: Diffusivity Equation, Radius of investigation, principle of superposition, Horner's approximation, Drill Stem Testing, Pressure Transient Tests, Well-test analysis by use of type curves, Gas well testing, Basic principles and mechanism of EOR, Screening of EOR process, Different Enhanced Oil Recovery Techniques and its applications.

Health Safety and Environment in Petroleum Industry: Health hazards in Petroleum Industry: Gas detection system. Fire detection and suppression systems. Personal protection system & measures. HSE Policies. The impact of drilling & production operations on environment. Offshore oil spill and oil spill control. Waste treatment methods.

Latest trends in Petroleum Engineering: Coal bed methane, shale gas, oil shale, gas hydrate, and heavy oil.