Syllabus for All Indian Written Examination for admission in M.Tech / M. Phil programmes

M.Tech. (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.

M.Tech (Fuel Engineering) and M.Tech (Mineral Engineering)

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.

M. Tech.(Mining Engg.)

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.

M.Tech. (Underground Space Technology)

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.

M. Tech. (Geomatics)

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.

M. Tech. (Industrial Engineering Management)

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.

M.Tech (Petroleum Engineering)

Thermodynamic properties of gas, oils, and waters: Phase behaviour of hydrocarbon systems ideal and non-ideal gases and liquid systems; qualitative and quantitative phase behavior.
Basic principles and characteristics of petroleum reservoirs: General composition and properties of oil and gas. Physical properties of oil and gas bearing rocks, porosity, fluid saturations, permeability, interfacial tension, wettability, capillary pressure, effective and relative permeability,
Fluid flow through porous media: Darcy's law, single and multiphase flow, linear, radial & spherical flow, steady state & unsteady state flow, An introduction to oil and gas material balance equations.
Fundamentals of oil & gas well drilling.
Fundamentals of Hydrocarbon production techniques and facilities.
Fundamentals of transportation and gathering of oil and gas.

M. Tech (Enviromental Sc. & Engg.)

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.

M Tech (Petroleum Exploration, Engineering Geology and Mineral Exploration)

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.

M.Tech. (Electronics & Communication Engineering)

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.

M.Tech (Mining Machinery and Engg.)

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.
Mining equipment in open-pit an underground mines.

M.Tech (Maintenance Engg. Tribology)

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.
Metal cutting; Metal forming; Non-traditional manufacturing; Computer aided manufacturing; Cellular manufacturing and group technology; Reverse engineering and rapid proto-typing.

M.Tech (Mechanical Engineering with specialization in Manufacturing Engg.)

Metal cutting: Theory of metal Cutting, Different classes of machine tools and their applications, Lathe, shaping, milling, drilling, grinding, Major process control parameters, Material removal rate.

Metal forming: Introduction to metal forming, Casting, different types of casting and their applications, Casting defects; Hot and Cold fording, wire drawing, deep drawing, rolling, calendaring, extrusion. Punching and blanking.

Non-traditional manufacturing processes: EDM, Wire EDM, USM, LBM, PAM, ECM.

Computer Aided Manufacturing: NC, DNC, CNC, CIM, FMS,AGV, Automation & Robotics**.**

Cellular manufacturing and Group Technology: Product and Process Layout, OPITZ Classification System, Cellular Manufacturing, ROC, Group Technology,

ReverseEngineering and Rapid Proto-typing: Forward Engineering, Reverse Engineering, Different Rapid prototyping processes, Stereolithography, Applications**.**

M-Tech in Power System Engineering (Department of Electrical Engineering)

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.

M.Phil (Applied Physics)

1. **CLASSICAL MECHANICS:**
   Generalised co-ordinates, Lagrange's equations, Hamilton's equations, Variational principle, Symmetries and conservation laws, central forces, collisions and scattering, Rotating co-ordinate system, Rigid body kinematics and dynamics, Euler's equations-symmetrical and asymmetrical top, Canonical transformations, Hamilton-Jacobi theory.
2. **SPECIAL THEORY OF RELATIVITY:**
   Frames of reference, Lorentz transformations, Doppler shift, Velocity addition, time dilation, Minkowski space-Four vectors, Proper time, Energy-momentum four vectors, Mass-energy equivalence, Relativistic force equation, Four tensors-Lorentz covariant & contra-variant equations.
3. **CONDENCED MATTER PHYSICS:**
   Crystal classes and systems, Bonding of common crystals, crystal structures, symmetries, reciprocal lattice, X-ray and neutron diffractions, Structure factor, point defects, and dislocations.
   Lattice vibrations, specific heat of solids, heat capacity, Free electron theory of metals, periodic potentials, energy bands in metals, insulators and semiconductors, tight binding approximation, impurity levels in doped semiconductors, Electronic transport, electrical and thermal conductivities, Hall effect. Dielectrics- Polarisation mechanisms, Claussius-Mossotti equation, Piezo-, Pyro, and Ferro-electricity. Dia-, Para-, Ferro-magnetisms, Ferri- and Antiferro magnetisms.
   Superconductivity-Phenomenology, Meissner effect, Type-I and Type-II super conductors, BCS theory.
4. **NUCLEAR PHYSICS:**
   General properties of nuclei, size, shape, charge distributions, spin and parity, nature of nuclear forces, nuclear models- liquid drop model, shell model and collective model. Interaction of charged particles and photons with matter.
   Nuclear detectors-ionization chambers, gas, proportional counters, GM counter, scintillation & semiconductor detectors, Radioactive decays – theoretical understanding, Nuclear reactions, nuclear fission and fusion, Classification of fundamental forces and elementary particles, iso-spin, strangeness, parity, symmetry and conservation laws, accelerators.
5. **QUANTUM MECHANICS:**
   Wave-particle duality, Heisenberg's uncertainty principle, Schrodinger wave equation, particle in a box, Harmonic oscillator, potential barrier and tunneling, Motion in a central potential, Hydrogen atom, canonical commutation relations, symmetries in quantum mechanics, spin, addition of angular momenta, Pauli's exclusion principle, Time independent perturbation theory, Fermi Golden rule, Approximation methods for bound states, WKB approximation, Time-dependent perturbation theory, scattering theory, Relativistic wave equations, Second quantization.

6. **STATISTICAL MECHANICS**
   Phase space, microstates and macro states, partition function, Free energy connection with thermo dynamical quantities, canonical and grand canonical ensembles, applications, kinetic theory, MB, BE and FD statistics of ideal gas, Black body radiation, and Plank's distribution law, Bose-Einstein's condensation, Einstein and Debye – theories of specific heat.

7. **ATOMIC AND MOLECULAR PHYSICS**
   Hydrogen atom spectrum, spin-orbit coupling, fine structure, spectroscopic terms and selection rules, hyperfine structure, L-S and J-J couplings, Zeeman, Paschen – Back and Stark effects, X-rays and Auger transition, Compton effect, Brief idea of molecular structure, Rotation and Rotation – vibration spectra of simple molecules, Frank – Condon principle, Raman spectra. Lasers – spontaneous and stimulated emissions, population inversion, optical pumping, description of He-Ne, CO_2 and Ruby Lasers.
8. **MATHAMETICAL PHYSICS:**
   Vector analysis, tensor analysis, Linear vector space, Matrix theory, complex variables, Differential equations, Special functions, Fourier integral and transforms, Laplace transforms.

M. Phil. (Applied Chemistry)

Structure and Bonding- Atomic structure, Bonding. Types of bonds. Structure of solid, crystal defects, lattice energy. Quantum chemistry- Schrodinger equation of free particle, particle in a box, degeneracy, harmonic oscillator, rigid rotator and hydrogen atom. Angular momentum including spin. Coupling of angular moment including spin-orbit coupling.
Spectroscopy- UV-VIS, IR and NMR Spectroscopy
Thermodynamics- First law of thermodynamics, relation between Cv and Cp. Enthalpies of physical and chemical changes. Second law of thermodynamics, entropy, Gibbs Helmholtz equation, free energy. Third law of thermodynamics.
Chemical equilibrium- Equilibrium constant, temperature dependence of equilibrium constants. Phase rule and phase equilibrium diagram. Phase diagram of one and two component system.
Solutions- Ideal and nonideal , Debye-Huckel treatment of dilute electrolyte solutions.
Acids and Bases- Bronsted and Lewis acids and bases, pH and pKa, acid concept in non aqueous media. HSAB concept
Electrochemistry- Electrochemical cell reactions, Nernst equation, Electrode kinetics, Electrical double layer, Batteries, Primary, secondary fuel cells. Corrosion and its prevention.
Reaction kinetics- First, Second, Third order reactions, collision and transition state theories of reaction rates. Theory of absolute reaction rates.
Organic reaction mechanism- Nucleophilic, Electrophilic, Free radical substitution, Addition and Elimination reactions Aldol, Perkin, Stobbe, Dieckmann condensasions, Hoffman, Schmidt, Lossen, Curtius, Beckmann and Fries rearrangement, Riemer-Tiemann, Reformatsky and Grignard reactions, Diels-Alder reaction, Claisen rearrangement, Friedel Craft reactions.
Stereochemistry and Conformational analysis- Recognition of symmetry elements and chiral structures, R,S nomenclature, Diastereoisomerism in acyclic and cyclic systems, E, Z isomers. Conformational analysis of cyclic (chair and boat) and acyclic systems. Interconversion of Fischer, Newmann and Sawhorse projections, Asymmetric synthesis, Stereoselective and stereospecific reactions.
Synthetic methodologies in organic chemistry
Nuclear Chemistry- Radioactive decay and equilibrium. Chemical effect of nuclear transformations, fission and fusion, Radioactive techniques, tracer techniques, Neutron activation analysis

Chemistry of Lanthanide and Actinides- Electronic configuration, Lanthanide contraction, isolation , application of lanthanide compounds as shift reagents, spectral and magnetic properties

Chemistry of Non-Transition Elements- Properties of non-transition elements, structure and properties of halides and oxides, polymorphism of carbon, Phosphorous and Sulphur. Synthesis and properties of borane, carboranes, borazines, silicate, carbides, silicones, phosphazenes, sulphur-nitrogen compounds, oxy acids of Nitrogen, Phosphorous, sulphur and halogens, inter halogens, pseudohalaides and noble gas compounds.

Organometallic Chemistry and Catalysis- 18-electron rule, Metal carbonyls, nitrosyls, dinitrogen complexes, alkyls, carbenes, carbynes, metallocenes (synthesis, structure and reactions), Fluxional molecules, and Catalysis.

Bio-inorganic Chemistry- Metalloporphyrins and respiration, Dioxygen bonding, transport & utilization; Enzymes, N_2 fixation.

M. Phil. (Applied Mathematics)

Calculus

Taylor's and Maclaurin's expansion of functions of several variables, maxima and minima of functions of two and three variables, Lagrange's method of undetermined multipliers, Beta and Gamma functions and its properties, evaluation of double and triple integrals and its application.

Matrix Theory

Orthogonal, Hermitian, skew-Hermitian and unitary matrices, rank and consistency conditions, linear and orthogonal transformations, eigen values and eigen vectors, Cayley-Hamilton theorem, reduction to normal form, quadratic forms, reduction of quadratic form to canonical form, signature.

Differential Equations

Method of variation of parameter, Cauchy and Legendre equations, simultaneous ordinary differential equations with constant coefficients.

Vector Calculus

Gradient, divergence and curl and their physical meaning, expansion formulae, line, surface and volume integrations, theorems of Green, Stokes and Gauss, orthogonal curvilinear coordinates, expression of gradient, divergence and curl in curvilinear coordinates.

Analysis of Complex Variables

Limit, continuity and differentiability of functions of complex variables, analytic functions, Cauchy-Riemann's equations, Cauchy's integral theorem, Morera's theorem, Cauchy's integral formula, expansion of function of complex variables in Taylor's and Laurent's series, singularities and poles, residue theorem, contour integration, conformal mappings and its application, bilinear transformation.

Integral Transform and Partial Differential Equations

Definition of Laplace transform and its properties, Laplace transform of general and special functions, Laplace transforms of derivatives and integrals, inverse Laplace transform,

convolution theorem, Fourier integral, Fourier transforms (general, sine and cosine) for various functions and its properties, inverse Fourier transform and convolution theorem, application of Laplace and Fourier transforms.
Introduction to P.D.E., linear and quasi-linear equations of first order, Lagrange's equations, Charpit's method, equations of second order P.D.E. with constant and variable coefficients, classification and reduction of second order equations to canonical form, Cauchy's, Neuman and Dirichlet's problems, solution of Laplace and Poisson's equation in two and three dimensions (Cartesian and polar coordinates) by variable separable method, solution of heat conduction and wave equations in one and two dimensions by variable separable and integral transform methods.

Numerical Methods

Solution of non-linear equations, solution of simultaneous linear equations, tridiagonal system, ill-conditioned system, matrix inversion by Gauss-Jordan and Crout's triangularisation methods, finite differences, interpolation by Newton-Gregory, Gauss, Sterling, Bessel, Everett, Lagrange and Newton's divided difference methods, inverse interpolation by Lagrange and iterative methods, numerical differentiation, numerical integration by Newton-Cote's formulae, numerical solution of first order ordinary differential equation by Taylor series, Picard's, Euler's, modified Euler's, Runge-Kutta and Milne's methods.

Orthogonal Functions

Elliptic integrals, Bessel functions of different kinds, integral representation of Bessel's functions, equation reducible to Bessel's equation, orthogonality of Bessel's function, modified Bessel's function, modified Bessel's function for large and small arguments, Legendre polymonial, Rodrigue's formula, orthogonality of Legendre polynomials.

Mathematical Statistics

Binomial, Poisson, negative binomial, hypergeometric distribution, normal, exponential, Gamma, Beta type I and type II distributions, central limit theorem.
Correlation and regression analysis: simple correlation, regression lines, multiple and partial regression (three variable case), rank correlation, intra-class correlation.
Sampling distributions: Chi-square, t and F.

Mechanics of Solids & Fluids

Analysis of stress, principal stresses, principal planes, maximum shearing stresses, Mohr's circle diagram, equations of deformation and strain, strain in terms of displacement, compatibility concept, need and physical significance, stress-strain relations, generalized Hooke's law, different types of symmetry, density function, solution of two dimensional problem of elasticity in Cartesian coordinates, Airy's stress function, wave propagation in unbounded elastic medium.
Methods of describing fluid motion: Lagrangian and Eulerian methods, streamlines, pathlines and streak lines, the material derivatives and acceleration, vorticity.
Fundamental equations of viscous fluid flow, laminar flow of viscous incompressible fluid, similarity of flows, flow between parallel flat plates, steady flow in pipes, flow between two concentric rotating cylinders, applications of the parallel flow theory, steady flow around a sphere, unsteady motion of a flat plate.

M. Phil (English)

1. Literary Theory and Criticism
2. British Literature (19^{th} and 20^{th} Century)
3. Literary Movements
4. Commonwealth Literature/American Literature/Indian English Literature/Literatures in Translation/Applied Linguistics
5. Literary Comprehension and Interpretation (Poetry Stanzas and Prose Passages)
6. Discourse Analysis
7. Cross-cultural Communication
8. Varieties of English
9. English Language Teaching (ELT)