



# MBM UNIVERSITY, JODHPUR

## (ACADEMIC CELL)

### Ph.D. ENTRANCE TEST SYLLABUS (SESSION: 2022-23)

Examination will be of 100 multiple choice based questions (of one mark each) of which 50 questions will be based on the paper 1 (RESEARCH METHODOLOGIES) and rest 50 questions will be from the respective discipline of engineering.

#### Research Methodology (Common for All Branches)

#### PAPER -1: RESEARCH METHODOLOGIES

##### Unit -1

##### Elements of learning:

Process of thinking or conceptualization of research, what is research

- a. Objectives of Research
- b. What makes to do research
- c. Importance

Types of Research

- a. Basic
- b. Applied

Stages of Research

- a. Selection of a Research topic and Problem
- b. Assessment of current status of topic chosen
- c. Definition of a research problem
- d. Literature survey and Reference collection
- e. Formulation of Hypothesis
- f. Research design and Actual Investigation
- g. Data Analysis, Interpretation of Results
- h. Report writing

##### Unit-II

##### Experimental Planning:

Designing of Experiments, Purpose of Research Design, Characteristics of Good Research Design

- a. Approaches to be used in solving problem
- b. Setting up of experiments
- c. Use of Animals, Animal ethics and Related laws, IAEC, Setting up experimental Groups
- d. Bio safety regulations in Biological Research (For life sciences only)
- e. Time frame
- f. Factorial design
- g. Variable, control and Standards
- h. Psychological bias

### **Unit-III**

#### **Data Analysis:**

- a. Data Collection and Tabulation
- b. Frequency distribution
- c. Diagrammatic and Graphical representation of Statistical data, Sampling technique, measures of sampling tendencies, Basis Statistics
- d. Standard Deviation and Standard error, Correlation and Regression, Basic idea of testing significance, level of significance, Students T test, chi-square test, F test and Analysis of variance, Basis knowledge of computer Statistical Programs-Prism, Sigma plot, SPSS
- e. Errors in Experiments, Propagation of Errors

### **Unit- IV**

#### **ICT in RESEARCH:**

##### **Computer & Internet:**

Basics of computers, Client server, Workstation, Parallel and Supercomputing. Different type of printers, Scanners.

##### **Software:**

OS, Windows OS, Application software. Networking, different LAN and WAN connections, connecting to a network, testing connection, Internet, IP address, Hypertext, Uniform Resource Locator, Web Browser, Domain Name, Internet Services Providers, Internet Security, Internet Requirements, Web Search Engine, Net Surfing.

### **Unit-V**

#### **Data Analysis and Display:**

Facilities in MS Excel for Data analysis and, display, Other data display soft-wares, Various Software's for Scientific and Statistical Analysis, SPSS: Creating a Database and simple Querying.

#### **Graphics and Drawing:**

##### **Adobe Photoshop:**

Basics, Image compression (GIF, JPEG, PNG formats), Multimedia, Digital Arts, Audio and Video formats, Multimedia Projections.

### **Unit-VI**

#### **Worksheet- MS-Excel:**

Worksheet basics, creating worksheet, entering into worksheet, heading information, data, text, dates, alphanumeric values, saving & quitting worksheet, Opening and moving around in an existing worksheet, Toolbars, Keyboard shortcuts, Working with single and multiple workbook, working with formulae & cell referencing, Auto sum, Coping formulae, Absolute & relative addressing, Worksheet with ranges, formatting of worksheet, Previewing & Printing worksheet, Graphs and charts, Database, Creating and Using macros.

### **Unit-VII**

#### **Presentation: MS Power Point:**

Creating slide show with animations. Autocentnt Wizard, creating a blank presentation, auto layout, Power point screen: screen layout and Views. applying design template, changing slide layout, slide show and editing custom slide. Adding notes, Video and Audio, Adding text Editing

options, Formatting text, Adding an image from a file Editing graphic, AutoShapes, Word Art, Action buttons Slide animation, Slide transitions.

### **Unit- VIII**

#### **Internet and Intranet:**

HTML, Web pages, creating a web page using MS Front page, adding graphics and images, Current web technologies, Hosting a web site, Advance search techniques, case studies: Google & Yahoo and Google Scholar. Building an Intranet

### **Unit-IX**

#### **Educational and Research resources on Net:**

##### **Encyclopedia case study:**

Wikipedia, on line Tutorials and Lectures, Java Applets, Educational Applets, Virtual Labs, Electronic Journals, E-books, digital libraries, Searching research information using J-gate and Scopus.

#### **Written Communication:**

E-mails, letters, memos, proposals, formal and informal reports, work plans, and progress reports. Oral Communication: Impromptu and extemporaneous methods of delivery. Oral presentations using visual aids such as handouts, overhead transparencies, and presentation software such as Power Point.

### **Unit-X**

Indexing of publications, Copy right and patent process/ agreement and publication of research papers or articles, Open excess and subscribed publications. Data mining sites: Publons, WoS (Web of Science), Science Direct, Clarivate analysis, Scopus, Google scholar, ORCID, Mendley stats, Academia.

# Department of Architecture & Town Planning

## **City planning:**

Evolution of cities; principles of city planning; types of cities & new towns planning regulations and building byelaws.

## **Housing:**

Concept of housing; neighborhood concept; site planning principles; housing typology; housing standards; housing infrastructure.

## **Landscape Design:**

Principles of landscape design and site planning; landscape elements and materials environmental considerations in landscape planning.

## **Computer Aided Design:**

Application of computers in architecture and planning; Understanding elements of computer graphics.

## **Environmental Studies in Building Science:**

Components of Ecosystem; ecological principles concerning environment; climate responsive design; energy efficient building design system; thermal comfort; solar architecture; principles of lighting and styles for illumination; basic principles of architectural acoustics; environment pollution, their control & abatement.

## **Visual and Urban Design:**

Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form, colour, texture; sense of place and space, division of space; barrier free design; focal point, vista.

## **History of Architecture:**

*Indian* – Indus valley and Mughal periods; *European* – Egyptian, Greek, Roman, medieval and renaissance periods- architectural styles;

## **Building Services:**

Water supply, sewerage and drainage systems; sanitary fittings and fixtures; plumbing systems, principles of internal & external drainage systems, airconditioning systems; fire fighting systems.

## **Building Construction and Management:**

Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination.

## **Materials and Structural Systems:**

Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, composites; principles of strength of materials.

# Department of Chemical Engineering

## **Process Calculations:**

Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

## **Thermodynamics:**

First and Second laws of thermodynamics. First law application to close and open systems. Second law and Entropy Thermodynamic properties of pure substances: equation of state and departure function, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibria.

## **Fluid Mechanics and Mechanical Operations:**

Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

## **Heat Transfer:**

Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

## **Mass Transfer:**

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption.

## **Chemical Reaction Engineering:**

Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time distribution, single parameter model; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

## **Instrumentation and Process Control:**

Measurement of process variables; sensors, transducers and their dynamics, transfer functions and dynamic responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response and controller tuning, cascade, feed forward control.

## **Plant Design and Economics:**

Process design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in design.

**Chemical Technology:**

Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

**Environmental Engineering:**

Drinking water standards, water requirements and unit processes for surface water treatment. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, sludge disposal, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment Unit operations and unit processes of domestic wastewater. Types of air pollutants, their sources and impacts, air pollution meteorology, air pollution control air quality standards and limits. Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

## Department of Civil Engineering

Fluid, its physical properties. Ideal and Real fluids. Newtonian and Non-Newtonian fluids. Principles of fluid statics: Pressure at a point, Absolute, gauge and vacuum pressures. Pressure measurements by manometers, Pressure gauges and Transducers. Total pressure and center of pressure on plane and curved immersed surfaces. Buoyancy, Floatation, Equilibrium of floating bodies, Metacentre and determination of metacentric height.

Kinematics of flow: Concepts of fluid flow – steady and unsteady flows, uniform and non-uniform flows, laminar and turbulent flows. Rotational and irrotational flows, Vorticity. Condition for two dimensional irrotational flows. Continuity equation in Cartesian co-ordinates. Stream function and Velocity potential for two dimensional flow, Laplace equation. Flownet and its characteristics. Equation of motion, energy and momentum applications: General hydrodynamic equations, Euler's equation of motion in Cartesian co-ordinates, Bernoulli's equation. Energy equation and its applications, Fluid masses subjected to uniform accelerations. Free and forced vortex flows.

### **Flow through pipes:**

Reynold's experiment, Minor losses, loss of head due to friction, Darcy's Weisbach equation, Hydraulic gradient and total energy lines. Pipes in series and parallel.

Flow through opening - Orifices, mouthpieces, nozzles, sluice gates, flow under varying head. Notches and Weirs: rectangular, triangular and trapezoidal notches and weirs Laminar Flow: Simple solution of Navier Stokes equations, Hagen-Poiseuille's equation, Shear stress distribution, Equation of motion for laminar flows, Stoke's law, Measurement of viscosity, Flow through parallel plates, Laminar flow through pipes, cavitations.

Turbulent Flow: Nature of turbulence, Reynold's momentum exchange concept and Prandtl's mixing length theory, Turbulent flow in pipes, equation for velocity, distribution and friction coefficient, velocity distribution in smooth pipes, rough pipes.

Introduction to boundary layer theory, Development of boundary layer over a thin flat plate, Laminar and turbulent boundary layers, boundary layer thickness and boundary shear (by momentum integral equation), boundary layer separations and control. The Prandtl boundary layer equation. Solution for laminar boundary layer.

Smooth and rough flat surfaces. Soil and rock, Soil mass constituents. Definition of water content, Specific gravity, Void ratio, Porosity, degree of saturation, air voids, density index etc. Phase relationship.

Group index, Unified and I.S. Soil classifications, field identification tests. Soil structure, basic clay minerals. Flocculated and dispersed clays.

Bearing capacity of soil. Terzaghi's analysis of bearing capacity of shallow foundations, skempton's and hansen's formula, local and general shear failure. Bearing capacity determination. Soil water, Permeability of soil and its determination.

Seepage and seepage pressure. Quick sand phenomena. Effective and total pressures. Laplace equation for seepage. Flow net and its uses, Piping; uplift pressure, Principle of drainage by Electro-osmosis. Principle of soil compaction and determination of field density. Field compaction and its control. Vertical pressure distribution in soil. Boussinesq's, equation. Vertical stress due to circular, rectangular and strip loaded areas, Contact pressure distribution.

Foundation: Function of foundation , requirement of foundation . Settlements of foundation Failure of foundation. Shallow & Deep Foundation, Wall foundation, isolated footing, raft foundation & Grillage foundation Pile foundation, pile driving machinery, pile caps.

Mohr circle of stress, shear strength of soil, its strength of sand and clays. Sensitivity and thixotrophy, skempton's pore pressure coefficient. Stress path.

Active, passive and at rest earth pressures, rank and coulomb's earth pressure theories, rebhann's and culmann's construction for cohesionless soil back fill. Uniformly distributed surcharge. Bell's equation for cohesive back fill. Stability of retaining wall, earth pressure on sheet piling and bulkheads.

Stability of slopes. Causes of slope failures. Stability analysis by Swedish and friction circle method for total and effective stresses, Taylor's method. Stability under sudden drawdown condition, Remedial measures.

One-dimensional consolidation of soil, Consolidation test. Terzaghi's one-dimensional consolidation theory and its use in predicting rate of settlement. Total and differential settlements. Over consolidated and normally consolidated soils.

Soil stabilisation, Mechanical stabilisation with lime, cement, bitumen, hydroscopic and water proofing chemicals. Electrochemicals and thermal stabilisation.

Sources of water supply, quantity of water per capita variation in seasonal and hourly consumption. Forecast of pollution. Standards of purity for public water supplies. Lakes, canal and rivers intakes. Raw water pumping. Quiescent and continuous flow types of tanks. Design & Theory of various units of water treatment plant. Disinfection – uses of excess lime, ozone, ultraviolet rays, chlorine and chloramines for disinfection, water softening. Different types of pipes used in water supply practice, joints in pipes, valves, distribution of water, Design of distribution system. Alignment, laying and jointing of pipes, Service reservoir and fittings service connection, detection and prevention of wastage of water, Metering, Rural Water Supply & sanitation.

Systems of drainage, Surface drainage, Under drainage, Separate, Combined and Partially combined system. House drainage – conservancy and water carriage systems, Various types of pipes used in waste water waste water management practice, various types of joints , junctions, various types of traps ,water closets, urinals and lavatory basins, waste and antisiphonage pipes. Alignment and gradient of drains. Inspection chambers. Testing of drains. Ventilation of drains.

Layout of sewerage systems, Design of sewerage network, estimation of sewage quantity , estimating storm water by time of concentration method. sewers appurtenances, Manholes, Flushing of sewers. Ventilation of sewers. Aerobic and anaerobic process of treatment. Sewage screening, grit separation, sewage pumping, Various means of disposal of sewage. Septic tank, Imhoff tank, contact beds, percolating filters. Activated sludge process. Nature of sewage sludge.



Sludge treatment, sludge gas. Collection and disposal of refuse. Principles, theory and design of various units of waste water treatment plants.

Basic principles of Solid waste management, transfer stations, composting, Basics of reuse , recovery and recycling. Waste to energy, land filling methods and operations. Biomedical waste management, Hazardous waste management.

Sources of air pollution, various types of pollutants, Dispersion of pollutants, atmospheric stability conditions, plume behaviours, estimation of effective height of stacks, Gaussain Plume Model. Global environmental problems, effects of air pollution on human, vegetation, animals & atmosphere etc. Control of particulate matter at source. Various air pollution control devices. Noise pollution its causes and effects.

### **Hydrology:**

Descriptive hydrology, hydrological cycle, hydrologic budget.

Precipitation, measurement and related data analyses, Hydrologic abstractions, Water losses, Evaporation and its estimation, transpiration, evapotranspiration, measurement of evapotranspiration, infiltration. Rainfall Runoff relationships, estimation quantity of runoff, flood estimation. Storm hydrograph, factors affecting flood hydrograph, unit and synthetic hydrographs, its application, storage routing. Streams and their gauging; Routing of floods; Capacity of Reservoirs. Regression and Correlation analysis.

### **Ground water:**

Forms of subsurface water, Aquifer properties and well irrigation: source of ground water, types of wells, steady flow into a well, Unsteady flow in a confined aquifer, well loss, specific capacity, Ground water budget, construction, yield, maintenance and development of wells.

### **River Engineering:**

River morphology; River training, embankments and Dikes, guide banks, groynes, Levees, spurs, Pitched island, cut off, bed pitching , butter panelling, design of launching apron, bank protection, Classification rivers on alluvial plains ,degrading, aggrading and meandering.

### **Dams:**

Basic principles for design and construction features of dams and spillways, forces on gravity dam, stability analysis, causes of failure, stress analysis, elementary profile, design of gravity dams, foundation treatment. Structural joints, keys and water seals, galleries, outlets.

### **Earth dams:**

Types, methods of construction, design and stability analysis. Estimation and control of seepage, slope protection. Brief description of Arch, Buttress dams, rockfill dams, coffer dams.

Orientation of buildings. Functional requirements of building. Planning for residential buildings. Design Loads Concept of Town Planning. Physical Planning and Social Planning. Building Materials, Masonry, various parts & units of buildings, joints in building Causes and effects of dampness, various methods of damp proofing of buildings, Shoring, underpinning and scaffolding.

**Ventilation & Air conditioning:**

Purpose of ventilation. Methods of ventilation, systems of ventilation. Rate of ventilation. Systems of air conditioning. Acoustics and Sound Insulation: General principles, sound absorbing materials, insulation of walls and floors. Acoustical correction, optimum time of reverberation.

**Fire Protection:**

Behaviours of different materials. Methods of fire proofing of walls, structural steel & wood.

Principles of surveying, compass survey, levelling, Plane Table Surveying, Theodolite Surveying, Traverse computation, Systems of co-ordinates, Adjustment of traverse, Tacheometric Surveying. Errors and precision in tacheometric surveying.

**Curves:**

Necessity of curves. Classification of curves-simple, compound, Reverse and vertical curves, transition curves. Hydrographic Surveying, Tunnel Surveying. Correlation of surface and underground surveys.

**Triangulation:**

Principles, objectives and classification. Triangulation layouts and figures. Station markers and signals Satellite stations. Strength of figure. Computation and adjustments in triangulation. Weight of observation, Least squares method, most probable values. Adjustment of quadrilateral and polygon with central station. Curvature and atmospheric refraction, single and reciprocal observations, Eye and object (axis-signal) correction.

**Photogrammetry:**

Introduction, limitation. Types of photographs, Aerial Photogrammetry, Photo coordinate system, Geometry and scale of vertical photographs. Ground coordinates from vertical photograph, Relief displacement. Flight planning, Planimetric mapping, photomaps and mosaics. Stereoscopy, Parallax, difference in elevation. Introduction to photo interpretation and remote sensing.

# Department of Computer Science & Engineering

## **Discrete Mathematics and Probability:**

Propositional and first order logic. Sets, relations, functions, partial orders and lattices. Groups. Graphs: connectivity, matching, coloring. Combinatorics: counting, recurrence relations, generating functions. Probability: Random variables. Uniform, normal, exponential, poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.

## **Digital Logic and Boolean Algebra:**

Combinational and sequential circuits. Boolean Algebra Minimization. Number representations and computer arithmetic (fixed and floating point).

## **Computer Organization and Architecture:**

Machine instructions and addressing modes. ALU, data-path and control unit. Instruction pipelining. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).

## **Programming and Data Structures:**

Programming in C/C++. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

## **Algorithms:**

Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide-and-conquer. Graph search, minimum spanning trees, shortest paths.

## **Theory of Computation:**

Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and context-free languages, pumping lemma. Turing machines and undecidability.

## **Compiler Design:**

Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation, optimization.

## **Operating System and System Software:**

Processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU scheduling. Memory management and virtual memory. File systems. Distributed operating System. System Software: linker, loader and interpreter.

## **Databases:**

ER-model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control. Distributed databases.

**Computer Networks and Network Security:**

Concept of layering. LAN technologies. Flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms. TCP/UDP and sockets, congestion control. Application layer protocols. Network security: authentication, public key and private key cryptography, digital signatures and certificates, firewalls. Mobile and wireless communication network.

**Software Engineering:**

Software development models, required analysis, software architecture, design, coding, testing maintenance, project planning estimation.

**Data Science:**

Data warehouse, data mining, Big data and Predictive Analytics.

**Artificial Intelligence:**

Knowledge representation and its uses, Artificial Neural Network, fuzzy logic and genetic algorithm. Machine learning.

# Department of Electronics & Communications Engineering

## Section 1: Networks, Signals and Systems

Network solution methods: nodal and mesh analysis; Network theorems: superposition, Thevenin and Norton's, maximum power transfer; Wye-Delta transformation; Steady state sinusoidal analysis using phasors; Time domain analysis of simple linear circuits; Solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits; Linear 2-port network parameters: driving point and transfer functions; State equations for networks. Continuous-time signals: Fourier series and Fourier transform representations, sampling theorem and applications; Discrete-time signals: discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform, interpolation of discrete-time signals; LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay, digital filter design techniques.

## Section 2: Electronic Devices

Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; Generation and recombination of carriers; Poisson and continuity equations; P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell; Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography and twin-tub CMOS process.

## Section 3: Analog Circuits

Small signal equivalent circuits of diodes, BJTs and MOSFETs; Simple diode circuits: clipping, clamping and rectifiers; Single-stage BJT and MOSFET amplifiers: biasing, bias stability, mid-frequency small signal analysis and frequency response; BJT and MOSFET amplifiers: multi-stage, differential, feedback, power and operational; Simple op-amp circuits; Active filters; Sinusoidal oscillators: criterion for oscillation, single-transistor and opamp configurations; Function generators, wave-shaping circuits and 555 timers; Voltage reference circuits; Power supplies: ripple removal and regulation.

## Section 4: Digital Circuits

Number systems; Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders and PLAs; Sequential circuits: latches and flip-flops, counters, shift-registers and finite state machines; Data converters: sample and hold circuits, ADCs and DACs; Semiconductor memories: ROM, SRAM, DRAM; 8-bit microprocessor (8085): architecture, programming, memory and I/O interfacing.

## Section 5: Control Systems

Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

## **Section 6: Communications**

Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems; Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, superheterodyne receivers, circuits for analog communications; Information theory: entropy, mutual information and channel capacity theorem; Digital communications: PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter receiver, calculation of bandwidth, SNR and BER for digital modulation; Fundamentals of error correction, Hamming codes; Timing and frequency synchronization, inter-symbol interference and its mitigation; Basics of TDMA, FDMA and CDMA.

## **Section 7: Electromagnetics**

Electrostatics; Maxwell's equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector; Plane waves and properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth; Transmission lines: equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart; Waveguides: modes, boundary conditions, cut-off frequencies, dispersion relations; Antennas: antenna types, radiation pattern, gain and directivity, return loss, antenna arrays; Basics of radar; Light propagation in optical fibers.

# Department of Electrical Engineering

## **Mathematics:**

Matrix Algebra, First order (Linear and Non-Linear) differential equations, Partial differential equations, Laplace Transform.

## **Circuit Theory:**

Thevenin's, Norton's, Superposition, Maximum Power Transfer Theorem and their applications to A.C. & D.C. circuits with dependent and independent sources, Transient response analysis of A.C. and D.C. networks, Three Phase Circuits.

## **Programming:**

Basic Concepts of C, Decision Making Looping, Functions, Parameter Passing, Recursion, Formatted Input & Output Statements.

## **Electronics:**

Diodes, Clipper, Clamper Circuits, Operational Amplifiers, BJT Amplifier, Biasing, Equivalent Circuits, Boolean Algebra, Combinational Circuits - Adder, Multiplexer, Encoders, Sequential Circuits-Flip flops, Counters.

## **Power Electronics:**

Uncontrolled & Controlled Rectifier Circuits, Principle of Choppers.

## **Measurement:**

Measurement of Voltage, Current, Power, Energy and Power Factor, Bridges Maxwell Inductance & Inductance- Capacitance, Schering & Wien Bridge.

## **Control System:**

Principle of Feedback System, Block Diagram, Signal Flow Graph, Time & Frequency domain Analysis, Introduction to state space representation of control system, Stability Analysis.

## **Power System:**

Fuse & Circuit Breakers, Over Current, Directional, Distance and Field Failure Relays. Protection of Generator & Transformer. Distance Protection & Bus-bar Protection, Thermal, Hydel and Nuclear Power Generation. Transmission & Distribution Systems.

## **Electrical Machines:**

D.C. Machines: Generator, Parallel Operation, Starting & Speed Control of D.C. Motor. Transformer: Voltage Regulation and Efficiency. Induction Motor: Torque-Slip Characteristics, Starting & Speed Control. Alternator Construction & Voltage Regulation Synchronous Motors, Performance Characteristics & Starting.

## Department of Mechanical Engineering

Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams; bending and shear stresses; torsion of circular shafts; Euler's theory of columns.

Free and forced vibration of single degree of freedom systems; critical speeds of shafts; gear trains; flywheels.

Design for static and dynamic loading; failure theories; fatigue strength and the  $\sigma$ -N diagram; Design of machine elements such as bolted, riveted and welded joints, shafts, spur gear, rolling and sliding contact bearing, brakes and clutches

Zeroth, first and second laws of thermodynamics; thermodynamic system and processes; Carnot cycle; irreversibility and availability; behavior of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamics cycle related to energy conversion.

Rankine, Brayton cycle with regeneration and reheat. I.C. Engines: air-standard Otto, Diesel cycle. Refrigeration and air-conditioning: Vapour refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle; psychrometric processes.

Differential equation of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc., Peltonwheel, Francis and Kaplan turbines-impulse and reaction principle, velocity diagrams.

Modes of heat transfer; one dimensional heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, application of correlations for heat transfer in laminar and turbulent flow over flat plates and through pipes; radiative heat transfer, black and grey surfaces, shape factor, network analysis; heat exchanger performance, LMTD and NTU methods.

Structure and properties of engineering materials, heat treatment, stress-strain diagram for engineering materials. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy.

Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures.

Basic concepts of CAM and NC programming.

Forecasting models, aggregate production planning, scheduling, material requirement planning. Deterministic and probabilistic models; safety stock inventory control systems.

Linear programming, simplex method, transportation, assignment, simple queuing model, PERT and CPM.



# Department of Mining Engineering

## **Mineral and Energy Resources:**

Mineral and Energy resources of Rajasthan, India and World.

## **Prospecting & Exploration:**

Prospecting & Exploration: Reconnaissance, Principles and Methods, Trenching & Pitting, boring methods, drilling muds, directional drilling.

## **Mine Entries and Under Ground Mine Development:**

Different mode of entries into a deposit to be worked out by underground mining, Their merits, demerits and suitability. Optimum location of an entry.

Horizontal Development: Shape, size and gradient of drives and tunnels. Drilling, blasting, loading, transport of muck and supports with conventional methods of driving small and medium size drifts and tunnels. Ventilation and drainage. Fast driving of tunnels using jumbos, borers. Trackless mucking and transportation units, Driving of large size drives and tunnels. Vertical Development: Conventional methods of raising, Raise climbers, long hole raising of driving.

## **Mining Machinery:**

Compressor : Types, principle, construction and use.

Rope Haulage : Types, construction, installation, operation and comparison.

Locomotives : Different types, construction, operation and comparison.

Wire Ropes : Types, construction, installation, maintenance and tests, space factor, rope splicing, different rope capels and capping process.

Winding: Shaft fittings, different types of winding systems and winders, braking, safety devices, detaching hooks, Comparison of drum winding and koepe winding systems.

## **Methods of Work:**

Underground Coal: Development & extraction of coal by “Board & pillar method” and longwall method”, variants of board & pillar method, depillaring, various machines used.

Opencast Mining : General details, basic definitions, determination of main parameters, opening of surface mines, disposal of overburden, major operations in surface mining viz. ground preparation, drilling, blasting, excavation, loading & transportation, Reclamation, machines used.

Underground Metal Mining: Basic information, details of various excavations and structures required for different purposes,

Stopping methods: Classification, development work required, stope preparation, haulage, dumping, ventilation, loading, hoisting and possible recovery from each method.

## **Ventilation:**

Mine Atmosphere : Composition, pollution, physiological affects of mine gases, their detection, heat and humidity in mines, their effect on mine workers, measurement and control, comfort conditions, geothermic gradient.

Ventilation : Necessity and standards of ventilations, laws of ventilation, mine resistance.

Natural Ventilation: Cause, initiation, measurement, motive column. Mechanical Ventilation: Mine fans, principle types, construction and working, booster and auxiliary fans.

Coursing: Distribution and regulation of air current, splitting, dead end ventilation, forcing v/s exhaust, accessional v/s descensional, homotropical v/s antitropical systems.

Ventilation Survey : Types, instruments used, methods, booking etc.

**Mine Environment:**

Environmental issues in mineral industry, Various pollutions caused by mining activities, their control and mitigation measures viz. Land, Air, Water, Noise, Social, Ground & Air vibration, etc. their measurement & permissible limits.

**Mine Legislation. :**

National Mineral policy, Statutory laws concerned with development and conservation of minerals, Mine and Minerals (Regulation and Development) Act, Mineral Concession Rules, Mineral Conservation and Development Rules, Mines Act, Coal Mines and Metalliferous Mines Regulation.

**Rock Mechanics:**

Application of rock mechanics in mining. Stress and strain in rocks, physico-mechanical properties of rock and their determination, Failure criteria of rock and rock mass, ground water, its influence on rock and mining, measurement of ground water flow and pressure.

**Mine Economics & Management:**

Mine Sampling: Theory, methods, precautions, estimation and calculations, mine valuation, life of mine and its present value, capital and operating cost, standard cost, budget and budgetary control.

Personnel management, training, human resources, job evaluation and incentives, work study, production planning, scheduling and control, productivity, PERT & CPM, purchase and store management, inventory control, value analysis.

**Mine Surveying:**

Theodolites, traversing, closing error, omitted measurements, leveling, tachometric surveying, contouring, interpolation of contours, curve ranging, correlation. Stope and face surveying, minor instruments, mine plan and sections, enlargement of plans, dip fault problems, total stations.

# Department of Production & Industrial Engineering

## **I. General Engineering**

1. Engineering Mathematics
2. Applied Mechanics
3. Design of Components and Assemblies

## **II. Production Engineering**

1. Metal Casting
2. Metal Forming
3. Metal Joining Processes
4. Machining and Machine Tool Operations
5. Tool Engineering
6. Metrology and Inspection
7. Material Science

## **III. Industrial Engineering**

1. Product design and Development
2. Engineering Economics
3. Study and Ergonomics
4. Facility Location and Layout
5. Production and Operations Management
6. Operations Research
7. Productivity Engineering
8. Quality Management
9. Reliability and Maintenance
10. Management Information System
11. Intellectual Property Rights
12. Entrepreneurship Development

## **IV. Automation**

1. CIM/CAD/CAM/CAPP
2. Robotics
3. Cellular Manufacturing
4. Mechatronics
5. Simulation
6. Soft Computing

Depth of competence for these topics would be of the level of Master Programmes in Prod. & Ind. Engg. and related courses followed across the country.

# Department of Structural Engineering

## **UNIT 01: STRUCTURAL ANALYSIS**

Basic Structural Analysis, Shear Centre, Buckling of axially loaded Columns. Introduction to Matrix Methods of Structural Analysis. Strain measuring devices. Generalised Hooke's law. Elastic Strain energy. Elementary Torsion problems.

## **UNIT 02: REINFORCED CONCRETE DESIGN**

Approximate methods of analysis for 2D frames under lateral loads. Structural systems for tall buildings. Concept of Shear walls. Yield line analysis of R.C. Slabs, Design of multistoried Buildings, Chimneys, Silos, Methods of Prestressing & Losses.

## **UNIT 03: DESIGN OF STEEL STRUCTURES**

Design of prefabricated steel buildings, framed and moment connections, semi rigid connections, design of steel bridges.

## **UNIT 04: FINITE ELEMENT METHOD**

Plane stress, Plane strain. One and two dimensional problems and their analysis.

## **UNIT 05: STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING**

Structural Dynamics, Single degree freedom of structure, Free & Forced vibration, Seismic Resistant Design. Introduction to IS 1893 part 01 and 02. Response Spectrum Analysis.