FACULTY OF ENGINEERING

SYLLABUS – Ph.D. ENTRANCE EXAMINATION

AUTOMOBILE ENGINEERING

Engineering materials, stress- strain behavior of metals and alloys; heat treatment, Manufacturing – Casting, Metal Forming, Welding, Powder metallurgy. Non-traditional Machining processes, CAD-CAM, CIM, Robotics, Metrology and Inspection, Engineering mechanics, Kinematics and dynamics, Fluid mechanics, Thermodynamics, heat transfer, I.C. Engines, Automotive design, Automotive transmission, Chassis, Vehicle body, Emissions and pollution control, Automotive air conditioning, Vehicle electrical and electronic system, Electric and hybrid vehicles, Vehicle coating and corrosion, Vehicle ergonomics, Automotive maintenance, Fault diagnosis and trouble-shooting, Quality management, Statistical quality control, Lean, Six sigma, Reliability. Product Development, Concurrent engineering; Quality function deployment, Industrial Engineering and Operations Management.

CHEMICAL ENGINEERING

Engineering Mathematics: Linear Algebra, Matrix algebra, Systems of linear equations, Eigen values and eigenvectors. Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one-dimensional heat and wave equations and Laplace equation.

Statistics: Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions, Linear regression analysis.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations. Integration by trapezoidal and Simpson's rule. Single and multi-step methods for numerical solution of differential equations

Process Calculations and Thermodynamics: Steady and unsteady state mass and energy balances including multiphase, multi-component, reacting and non-reacting systems. Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis. First and Second laws of thermodynamics. Applications of first law to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual

properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

Fluid Mechanics: Fluid statics, Newtonian and non-Newtonian fluids, shell-balances including differential form of Bernoulli equation and energy balance, Macroscopic friction factors, flow through pipeline systems, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds.

Heat Transfer: Steady and unsteady heat conduction, convection and radiation, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations. Design of double pipe, shell and tube heat exchangers, single and multiple effect evaporators.

Mass Transfer: Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage-wise 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.

CIVIL ENGINEERING

Engineering Mechanics: System of Coplanar Forces, Centroid and Moment of Inertia, Friction, Kinematics of a particle, Kinematics of rigid bodies, Momentum and Energy principles.

Fluid mechanics: Fluid statics, Pressure measurement, Buoyancy & floatation, Fluid kinematics, Flow measurement, Orifices, Mouth pieces, Notches, Weirs, Flow through pipes, Laminar flow & Turbulent flow, Boundary layer theory, Flow through channels.

Structural Analysis: Shear force and bending moment diagrams, Simple Stresses and strains, Shear stresses in beams, Principal stresses and strains, Direct and bending stresses, Columns and struts,

FACULTY OF ENGINEERING

SYLLABUS – Ph.D. ENTRANCE EXAMINATION

Thin cylinders. Fixed beams, Continuous beams, Moving loads, Influence lines, Strain energy, Columns, Three-hinged arches, Two-hinged arches, Suspension bridges.

Concrete Technology: Cement, Aggregates, Water, Admixtures, Fresh concrete, Properties of hardened concrete, Concrete mix design.

Structural Design Concrete Structures: Basic Working stress and Limit state design concepts, Analysis for ultimate load capacity. Design of members subjected to flexure, Shear, compression and torsion by Limit State methods. Basic elements of pre-stressed 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.

Geotechnical Engineering Soil Mechanics: Structure of soil, Three-phase System, Index properties of soils, Classification of soils, Permeability of soils, Compressibility, Compaction, Shear strength, Exploration and *in-situ* soil measurements.

Foundation Engineering: Sub-surface investigations- Scope, Drilling bore holes, Sampling, Penetration tests, Plate load test. Foundation types-, Pile types, Dynamic & static formulae, Load capacity of piles in sands & clays, Negative skin friction.

Water Resources Engineering Hydrology, Precipitation, Infiltration, Evaporation and evapotranspiration, Run-off, Hydrographs, Floods, Ground water hydrology, Irrigation

Environmental Engineering Water Supply Engineering: Introduction to water supply, Quality of water, Sources of water, Raw water conveyance, Treatment of water, Distribution of water

Sanitary Engineering: Sewage and sewerage, Sewer design, Sewer appurtenances, Sewer pump

Air Pollution: Types of pollutants – their sources and impact, Air pollution meteorology, Air pollution control, Air quality standards and limits.

Transportation Engineering Geometric design of highways, Testing and specifications of paving materials, Design of flexible and rigid pavements.

Traffic characteristics: Theory of traffic flow, Intersection design, Traffic signs and Signal design, Highway capacity.

Surveying Measurement of horizontal distances, Chain surveying, Measurement of angles, Measurement of elevations, Theodolite surveying, Tacheometric surveying, Curves, Hydrographic surveying.

FACULTY OF ENGINEERING

SYLLABUS – Ph.D. ENTRANCE EXAMINATION

COMPUTER SCIENCE AND INFORMATION TECHNOLOGY (CSE, CCE & IT)

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Digital Logic: Logic functions, Minimization, Design and synthesis of combinational and sequential circuits; Number representation.

Computer Organization and Architecture: Machine instructions and addressing modes, ALU and data-path, CPU control design, Memory interface, I/O interface (Interrupt and DMA mode), Instruction pipelining, Cache and main memory, Secondary storage, 8085 microprocessor.

Programming and Data Structures: Programming in C/C++; Functions, Recursion, Parameter passing, Scope, Binding; Abstract data types, Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Binary heaps.

Algorithms: Divide & conquer, Branch & bound, Dynamic programming, Greedy techniques, NP-Hard & NP Complete.

Theory of Computation: Regular languages and finite automata, Context free languages and Push-down automata.

Compiler Design: Lexical analysis, Parsing, Syntax directed translation.

Operating Systems: Processes, threads, Inter-process communication, concurrency, Semaphores, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, protection and security.

Databases: ER-model, Database design (integrity constraints, normal forms), Query languages (SQL). Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Computer Networks: ISO/OSI stack, LAN technologies (Ethernet), Flow and error control techniques, TCP/UDP and sockets, IP(v4), Application layer protocols, Basic concepts of hubs, switches, gateways, and routers. Network security – basic concepts of public key and private key cryptography, digital signature, firewalls.

FACULTY OF ENGINEERING

SYLLABUS – Ph.D. ENTRANCE EXAMINATION

ELECTRICAL ENGINEERING

Electric Circuits and Networks: Network graph, Node and Mesh analysis, Transient response of DC and AC networks, Time Domain & Frequency Domain Analysis using Laplace and Fourier Transformations.

Network Theorems: Thevenin's, Norton's, Superposition and Maximum Power Transfer Theorems, Star-Delta Transformations, Source Transformation. Analysis of Two-port networks: H, Y, Z and ABCD parameters representations. Magnetic Circuits. Single phase and Three phase circuits.

Power Systems: Basic concepts of Generation, Transmission and Distribution of Electrical Power, Models and Representation of Power System components; Synchronous Machines, Transformers, Transmission Lines etc. Per Unit Representations, Symmetrical Components, Fault Analysis (LG, LLG, LL, LLLG faults), Bus impedance and Admittance Matrices, Load Flow Analysis and Solution Techniques, Voltage Control, Reactive Power Compensation and Power Factor Correction, Economic Operation, Power System Stability – Angle and Voltage Stability, HVDC Transmission and FACTS Devices, Protection Systems - Relays and Circuit Breakers.

Electrical Machines: Single and Three Phase Transformer – Equivalent circuit, Phasor diagram, tests, regulation and efficiency, parallel operation; Auto-transformer; Energy conversion principles; DC machines – types, windings, generator characteristics, armature reaction and commutation, starting and speed control of motors; Single & Three Phase Induction Motors – principles, types, performance characteristics, starting and speed control; Synchronous Machines – construction, performance, regulation and parallel operation of generators, motor starting, characteristics and applications.

Power Electronics and Drives: Semiconductor Power Diodes, Transistors, Thyristors, Triacs, GTOs, MOSFETs and IGBTs – static characteristics and principles of operation; Triggering circuits; Phase control rectifiers; bridge converters – fully controlled and half controlled; principles of choppers and inverters; Basis concepts of adjustable speed dc and ac drives.

Control Systems: Principles of Open Loop and Feedback; Transfer Function; Block Diagrams; Steady-State Errors; Routh and Nyquist Techniques; Bode Plots; Root loci; Lag, Lead and Lead-lag compensation; State Space Model; State Transition Matrix, Controllability and Observability.

FACULTY OF ENGINEERING

SYLLABUS – Ph.D. ENTRANCE EXAMINATION

Signals and Systems: Representation of continuous and discrete-time signals; shifting and scaling operations; Linear, Time-invariant and causal systems; Fourier series representation of continuous periodic signals; Sampling Theorem; Fourier, Laplace and Z transforms.

Engineering Mathematics: Matrix Algebra, Vector Calculus, Fourier series, Differential equations -linear and nonlinear. Partial Differential Equations, Probability and Statistics, Numerical Methods, Solutions of Non-linear algebraic equations, single and multi-step methods for differential equations. Transform Theory - Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING (ECE)

Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Energy bands in silicon, intrinsic and extrinsic silicon.

Carrier transport in silicon: diffusion current, drift current, mobility, and resistivity. Generation and recombination of carriers, PN junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, PIN and avalanche photo diode, Basics of LASERs. Small Signal Equivalent circuits of diodes, BJTs, MOSFETs and analog CMOS. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor; FET amplifiers. Amplifiers: Boolean algebra, minimization of Boolean functions; logic gates; Definitions and properties of Laplace transform continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform.

Digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), TDMA, FDMA and CDMA and GSM.

Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms, wave equation, Poynting vector.

Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth.

Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; S parameters, pulse excitation.

Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Basics of propagation in dielectric waveguide and optical fibers.

FACULTY OF ENGINEERING

SYLLABUS – Ph.D. ENTRANCE EXAMINATION

Basics of Antennas: parameters, array antennas, measurements; frequency band, microwave components, TWT, Gun diode, different types of radar, radar antennas, radar range equation.

MECHANICAL ENGINEERING

Metal Casting: Design of patterns, moulds and cores; solidification and cooling; riser and gating design, design considerations.

Forming: Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk and sheet metal forming processes; principles of powder metallurgy. **Joining:** Physics of welding, brazing, and soldering; adhesive bonding; design considerations in welding.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials.

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum, and energy; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc. **Heat-Transfer:** Modes of heat transfer; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods. **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 thermodynamic cycles related to energy conversion. **Engineering Mechanics:** Free body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, thin cylinders; shear force and bending moment diagrams; bending and shear stresses.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of slider-crank mechanism; gear trains; flywheels.

FACULTY OF ENGINEERING

SYLLABUS – Ph.D. ENTRANCE EXAMINATION

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Inventory Control: Deterministic and probabilistic models; safety stock inventory control systems.

Operations Research: Linear programming, simplex and graphical method, transportation model, assignment model, network flow models, simple queuing models, PERT and CPM. Supply Chain Management.

MECHATRONICS ENGINEERING

Design Of Robotic Components: Motion control analysis of actuators, Control parameters and system objectives, Motion control algorithms, Architecture of intelligent machines, Homogenous transformations.

Intelligent Controllers: Single layer feed forward networks, multilayer feed forward networks, single layer feedback networks, multilayer feedback networks, Fuzzy control, Stability Analysis of Control Systems; time domain specifications for second order systems, Steady state errors, Frequency domain analysis, Stability analysis, Routh Hurwitz criterion, Root locus plots, Nyquist criterion

Numerical Analysis: Mathematical modeling of Engineering problems, Roots of equations, Linear Algebraic Equations, Numerical differentiation and Integration, Numerical solutions to differential equations.

MANIPAL UNIVERSITY JAIPUR

FACULTY OF ENGINEERING

DEPARTMENT OF BIOTECHNOLOGY AND CHEMICAL ENGINEERING

SYLLABUS – Ph.D. ENTRANCE EXAMINATION

Chemical Engineering and Biotechnology

Engineering Mathematics: Linear Algebra, Matrix algebra, Systems of linear equations, Eigen values and eigenvectors. Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one-dimensional heat and wave equations and Laplace equation.

Statistics: Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions, Linear regression analysis.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations. Integration by trapezoidal and Simpson's rule. Single and multi-step methods for numerical solution of differential equations

Process Calculations and Thermodynamics: Steady and unsteady state mass and energy balances including multiphase, multi-component, reacting and non-reacting systems. Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis. First and Second laws of thermodynamics. Applications of first law to close and open systems. Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

Fluid Mechanics: Fluid statics, Newtonian and non-Newtonian fluids, shell-balances including differential form of Bernoulli equation and energy balance, Macroscopic friction factors, flow through pipeline systems, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds.

Heat and Mass Transfer: Steady and unsteady heat conduction, convection and radiation, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations. Design of double pipe, shell and tube heat exchangers, single and multiple effect evaporators. Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage-wise 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.

General Biology: Biomolecules, basic concepts and regulation of metabolism of biomolecules; Photosynthesis, Enzymes, Enzyme inhibition. Bacterial classification and diversity; Microbial Ecology and interactions; Viruses - structure and classification; Methods in microbiology; Microbial growth and nutrition; Nitrogen fixation; Microbial diseases and host-pathogen interactions; Antibiotics and antimicrobial resistance. Immunology: Innate and adaptive immunity, humoral and cell mediated immunity; Antibody structure and function; Molecular basis of antibody diversity; T cell and B cell development; Antigen-antibody reaction; Complement; Primary and secondary lymphoid organs; Major histocompatibility complex (MHC); Antigen processing and presentation; Polyclonal and monoclonal antibody; Regulation of immune response; Immune tolerance; Hypersensitivity; Autoimmunity; Graft versus host reaction; Immunization and vaccines.

Genetics, Cellular and Molecular Biology: Mendelian inheritance; Gene interaction; Complementation; Linkage, recombination and chromosome mapping; Extra chromosomal inheritance; Microbial genetics - transformation, transduction and conjugation; Horizontal gene transfer and transposable elements; Chromosomal variation; Genetic disorders; Population genetics; Epigenetics; Selection and inheritance; Adaptive and neutral evolution; Genetic drift; Species and speciation. Prokaryotic and eukaryotic cell structure; Cell cycle and cell growth control; Cell-cell communication; Cell signaling and signal transduction; Post-translational modifications; Protein trafficking; Cell death and autophagy; Extra-cellular matrix. Molecular structure of genes and chromosomes; Mutations and mutagenesis; Regulation of gene expression; Nucleic acid - replication, transcription, splicing, translation and their regulatory mechanisms; Non-coding and micro RNA; RNA interference; DNA damage and repair.

Plant, Animal and Microbial Biotechnology: Totipotency; Regeneration of plants; Plant growth regulators and elicitors; Tissue culture and cell suspension culture system - methodology, kinetics of growth and nutrient optimization; Production of secondary metabolites; Hairy root culture; Plant products of industrial importance; Artificial seeds; Somaclonal variation; Protoplast, protoplast fusion - somatic hybrid and cybrid; Transgenic plants - direct and indirect methods of gene transfer techniques; Selection marker and reporter gene; Plastid transformation. Animals: Culture media composition and growth conditions; Animal cell and tissue preservation; Anchorage and non-anchorage dependent cell culture; Kinetics of cell growth; Micro & macro-carrier culture; Hybridoma technology; Stem cell technology; Animal cloning; Transgenic animals; Knockout and knock-in animals. Microbes: Production of biomass and primary/secondary metabolites - Biofuels, bioplastics, industrial enzymes, antibiotics; Large scale production and purification of recombinant proteins and metabolites; Clinical-, food- and industrial- microbiology; Screening strategies for new products.

Recombinant DNA technology and Other Tools in Biotechnology: Recombinant DNA technology: Restriction and modification enzymes; Vectors, Gene isolation and cloning, strategies for production of recombinant proteins; Transposons and gene targeting; Molecular tools such as PCR, labelling and sequencing, blotting, DNA fingerprinting, RAPD, RFLP; Site-directed mutagenesis; Gene transfer technologies; CRISPR-Cas; Biosensing and biosensors. Analytical tools: Principles of microscopy, and spectroscopy, Enzymatic assays, Immunoassays. Computational tools: Bioinformatics resources and search tools; Sequence and structure databases; Sequence analysis - sequence file formats, scoring matrices, alignment, phylogeny; Genomics, proteomics, metabolomics; Gene prediction; Functional annotation; Secondary structure and 3D structure prediction; Knowledge discovery in biochemical databases; Metagenomics; Metabolic engineering and systems biology.