

# MAHARAJA RANJIT SINGH STATE TECHNICAL UNIVERSITY, BATHINDA

(Established by Govt. of Punjab vide Punjab Act No. 5 of 2015)

## PhD ADMISSION SYLLABUS FOR PET

FACULTY:- SCIENCES

DISCIPLINE:- CHEMISTRY

### SYLLABUS FOR PhD ENTRANCE TEST (PET) (SECTION I/TECHNICAL SECTION)

Same as prescribed for NET (National Eligibility Test) for Chemistry conducted by UGC-CSIR.

#### **INORGANIC CHEMISTRY:**

1. Chemical periodicity
2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).
3. Concepts of acids and bases, Hard-Soft acid base concept, Non-aqueous solvents.
4. Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds.
5. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms.
6. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications.
7. Organometallic compounds: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis.
8. Cages and metal clusters.
9. Analytical chemistry- separation, spectroscopic, electro- and thermoanalytical methods.
10. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine.
11. Characterization of inorganic compounds by IR, Raman, NMR, EPR, Mossbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.
12. Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

#### **PHYSICAL CHEMISTRY:**

1. Basic principles of quantum mechanics: Postulates; operator algebra; exactly-solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunneling.
2. Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.
3. Atomic structure and spectroscopy; term symbols; many-electron systems and antisymmetry principle.
4. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated  $\pi$ -electron systems.
5. Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules.
6. Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.
7. Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.
8. Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.
9. Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.
10. Chemical kinetics: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.
11. Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.

12. Solid state: Crystal structures; Bragg's law and applications; band structure of solids.
13. Polymer chemistry: Molar masses; kinetics of polymerization.
14. Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

#### **ORGANIC CHEMISTRY:**

1. IUPAC nomenclature of organic molecules including regio- and stereoisomers.
2. Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.
3. Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.
4. Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzyne and nitrenes.
5. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.
6. Common named reactions and rearrangements – applications in organic synthesis.
7. Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations.
8. Concepts in organic synthesis: Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.
9. Asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic.
10. Pericyclic reactions – electrocyclicisation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.
11. Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).
12. Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.
13. Structure determination of organic compounds by IR, UV-Vis, <sup>1</sup>H & <sup>13</sup>C NMR and Mass spectroscopic techniques.

#### **INTERDISCIPLINARY TOPICS:**

1. Chemistry in nanoscience and technology.
2. Catalysis and green chemistry.
3. Medicinal chemistry.
4. Supramolecular chemistry.
5. Environmental chemistry.

**FACULTY:- SCIENCES**

**DISCIPLINE:- COMPUTER APPLICATION**

#### **SYLLABUS FOR PhD ENTRANCE TEST (PET) (SECTION I/TECHNICAL SECTION)**

##### **1.Programming in C and C++ :**

Elements of C and C++ – Tokens, identifiers, Variables and constants ,Data types in C and C++. Control structures in C and C++. Sequence, selection and iteration(s). O – O Programming Concepts : Class, object, instantiation. Inheritance, polymorphism and overloading. Constructors and destructors. Overloading, Inheritance, Templates, Exception handling, Functions parameter passing.

##### **2.Relational Database Design and SQL :**

Database Concepts, ER diagrams and their transformation to relational design, Data Models, Design of Relational Database, Normalisation, SQL and QBE, Query Processing and Optimisation, Centralised and Distributed Database, Security, Concurrency and Recovery in Centralised and Distributed Database Systems, Object Oriented Database Management Systems ( Concepts, Composite objects, Integration with RDBMS applications ), ORACLE

##### **3. Discrete Structures :**

Sets, Relations, Functions. Pigeonhole Principle, Inclusion-Exclusion Principle, Equivalence and Partial Orderings, Elementary Counting Techniques, Probability. Measure ( s ) for information and Mutual information.

**Graph :** Definition, walks, paths, trails, connected graphs, regular and bipartite graphs, cycles and circuits. Tree and rooted tree. Spanning trees. Eccentricity of a vertex radius and diameter of

a graph. Central Graphs. Centres of a tree. Hamiltonian and Eulerian graphs, Planar graphs.

**Groups :** Finite fields and Error correcting / detecting codes.

#### **4. Data and File structures :**

Introduction to Data Structure, Arrays, stacks, queues, linked lists, trees, graphs, priority queues and heaps.

File Structures : Fields, records and files. Sequential, direct, index-sequential and relative files. Hashing, inverted lists and multi – lists. B trees and B+ trees.

#### **5. Computer Arithmetic :**

Propositional ( Boolean ) Logic, Predicate Logic, Well – formed – formulae ( WFF ), Satisfiability and Tautology.

Logic Families : TTL, ECL and C – MOS gates. Boolean algebra and Minimization of Boolean functions. Flip-flops. Design of combinational and sequential circuits.

Representation of Integers : Octal, Hex, Decimal, and Binary. 2's complement and 1's complement arithmetic. Floating point representation.

#### **6. System Software and Compilers :**

- Assembly language fundamentals ( 8085 based assembly language programming ). Assemblers-2-pass and single-pass. Macros and macroprocessors.
- Loading, linking, relocation, program relocatability. Linkage editing.
- Text editors. Programming Environments. Debuggers and program generators.
- Compilation and Interpretation. Bootstrap compilers. Phases of compilation process. Lexical analysis. Lex package on Unix system.
- Context free grammars. Parsing and parse trees. Representation of parse ( derivation ) trees as rightmost and leftmost derivations. Bottom up parsers-shift-reduce, operator precedence, and LR. YACC package on Unix system.
- Topdown parsers-left recursion and its removal. Recursive descent parser. Predictive parser. Intermediate codes-Quadruples, Triples, Intermediate code generation, Code generation, Code optimization.

#### **7. Operating Systems ( with Case Study of Unix ) :**

Main functions of operating systems. Multiprogramming, multiprocessing, and multitasking.

**Memory Management :** Virtual memory, paging, fragmentation.

**Concurrent Processing :** Mutual exclusion. Critical regions, lock and unlock.

**Scheduling :** CPU scheduling, I/ O scheduling, Resource scheduling. Deadlock and scheduling algorithms. Banker's algorithm for deadlock handling.

**UNIX :** File system, process management, bourne shell, shell variables, command line programming, Filters and Commands, System Calls, Structure of Unix Operating System, Unix Commands, Interfacing with Unix, Editors and Compilers for Unix, LEX and YACC, File system, System calls, Filters, Shell programming

#### **8. Computer Networks :**

**Network fundamentals :** Local Area Networks ( LAN ), Metropolitan Area Networks ( MAN ), Wide Area Networks ( WAN ), Wireless Networks, Inter Networks.

**Reference Models :** The OSI model, TCP / IP model.

**Data Communication :** Channel capacity. Analog and Digital transmission, Asynchronous and Synchronous transmission, Transmission media-twisted pair, coaxial cables, fibre – optic cables, wireless transmission-radio, microwave, infrared and millimeter waves. Lightwave transmission. Telephones – local loop, trunks, multiplexing, switching, narrowband ISDN, broadband ISDN, ATM, High speed LANS. Cellular Radio. Communication satellites-geosynchronous and low-orbit.

**Internetworking :** Switch / Hub, Bridge, Router, Gateways, Concatenated virtual circuits, Tunnelling, Fragmentation, Firewalls.

**Routing :** Virtual circuits and datagrams. Routing algorithms. Congestion control.

**Network Security :** Cryptography-public key, secret key.

#### **9. Software Engineering :**

- **System Development Life Cycle ( SDLC ) :** Steps, Water fall model, Prototypes, Spiral model.
- **Software Metrics :** Software Project Management.
- **Software Design :** System design, detailed design, function oriented design, object oriented design, user interface design. Design level metrics.
- **Coding and Testing :** Testing level metrics. Software quality and reliability. Clean room approach, software re engineering.

#### **10. Current Trends and Technologies :**

The topics of current interest in Computer Science and Computer Applications shall be covered. The experts shall use their judgement from time to time to include the topics of popular interest, which are expected to be known for an application development software professional, currently, they include :

**Parallel Computing :**

Parallel virtual machine ( pvm ) and message passing interface ( MPI ) libraries and calls. Advanced architectures. Today's fastest computers.

**Mobile Computing :**

Mobile connectivity – Cells, Framework, wireless delivery technology and switching methods, mobile information access devices, mobile data internetworking standards, cellular data communication protocols, mobile computing applications. Mobile databases – protocols, scope, tools and technology. M-business.

**E – Technologies :**

- **Electronic Commerce :** Framework, Media Convergence of Applications, Consumer Applications, Organisation Applications.
- **Electronic Payment Systems :** Digital Token, Smart Cards, Credit Cards, Risks in Electronic Payment System, Designing Electronic Payment Systems.
- **Electronic Data Interchange ( EDI ) :** Concepts, Applications, ( Legal, Security and Privacy ) issues, EDI and Electronic Commerce, Standardization and EDI, EDI Software Implementation, EDI Envelope for Message Transport, Internet – Based EDI.
- **Broadband Telecommunications :** Concepts, Frame Relay, Cell Relay, Switched Multimegabit Data Service, Asynchronous Transfer Mode. Main concepts in Geographical Information System ( GIS ), E – cash, E – Business, ERP packages.
- **Data Warehousing :** Data Warehouse environment, architecture of a data warehouse methodology, analysis, design, construction and administration.
- **Data Mining :** Extracting models and patterns from large databases, data mining techniques, classification, regression, clustering, summarization, dependency modelling, link analysis, sequencing analysis, mining scientific and business data.

**10.Windows Programming :**

Introduction to Windows programming – Win32, Microsoft Foundation Classes ( MFC ), Documents and views, Resources, Message handling in windows.

**Simple Applications ( in windows ) :** Scrolling, splitting views, docking toolbars, status bars, common dialogs.

**11.Theory of Computation :**

Formal language, Need for formal computational models, Non-computational problems, diagonal argument and Russel's paradox.

Deterministic Finite Automaton ( DFA ), Non – deterministic Finite Automaton ( NFA ), Regular languages and regular sets, Equivalence of DFA and NFA. Minimizing the number of states of a DFA. Non-regular languages, and Pumping lemma.

Pushdown Automaton ( PDA ), Deterministic Pushdown Automaton ( DPDA ), Non – equivalence of PDA and DPDA.

Context free Grammars : Greibach Normal Form ( GNF ) and Chomsky Normal Form ( CNF ), Ambiguity, Parse Tree Representation of Derivations. Equivalence of PDA's and CFG's. Parsing techniques for parsing of general CFG's – Early's, Cook – Kassami-Younger ( CKY ), and Tomita's parsing.

Linear Bounded Automata ( LBA ) : Power of LBA Closure properties.

Turing Machine ( TM ) : One tape, multitape. The notions of time and space complexity in terms of TM. Construction of TM for simple problems. Computational complexity.

Chomsky Hierarchy of languages : Recursive and recursively-enumerable languages.

**12.Computer System Architecture :**

Combinational Circuit Design, Sequential Circuit Design, Hardwired and Micro Programmed processor design, Instruction formats, Addressing modes, Memory types and organisation, Interfacing peripheral devices, Interrupts.

Microprocessor architecture, Instruction set and Programming ( 8085, P – III / P – IV ), Microprocessor applications.

**13.Computer Graphics:**

- Display systems, Input devices, 2D Geometry, Graphic operations, 3D Graphics, Animation, Graphic standard, Applications.
- Concepts, Storage Devices, Input Tools, Authoring Tools, Application, Files.

**14.Design and Analysis of Algorithm:**

Analysis of Algorithms, Interpolation and Binary Search, Asymptotic notations-big oh, omega and theta. Average case analysis of simple programs like finding of a maximum of n elements. Recursion and its systematic removal. Quicksort – Non – recursive implementation with minimal stack storage. Design of Algorithms ( Divide and Conquer, Greedy method, Dynamic programming, Back tracking, Branch and Bound ). Lower bound theory, Non – deterministic algorithm – Non – deterministic programming constructs. Simple non-deterministic programs. NP – hard and NP – complete problems.

**15.Artificial Intelligence :**

- Definitions, AI approach for solving problems.

- Automated Reasoning with propositional logic and predicate logic-fundamental proof procedure, refutation, resolution, refinements to resolution ( ordering / pruning / restriction strategies ).
- State space representation of problems, bounding functions, breadth first, depth first, A, A\*, AO\*, etc. Performance comparison of various search techniques.
- Frames, scripts, semantic nets, production systems, procedural representations. Prolog programming.
- Components of an expert system, Knowledge representation and Acquisition techniques, Building expert system and Shell.
- RTNs, ATNs, Parsing of Ambiguous CFGs. Tree Adjoining Grammars ( TAGs ).
- Systems approach to planning, Designing, Development, Implementation and Evaluation of MIS.
- Decision-making processes, evaluation of DSS, Group decision support system and case studies, Adaptive design approach to DSS development, Cognitive style in DSS, Integrating expert and Decision support systems.

**FACULTY:- SCIENCES**

**DISCIPLINE:- PHYSICS**

**SYLLABUS FOR PhD ELIGIBILITY TEST (SECTION I/ TECHNICAL SECTION):**

**I. Mathematical Methods of Physics**

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem. Green's function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge- Kutta method. Finite difference methods. Tensors. Introductory group theory: SU(2), O(3).

**II. Classical Mechanics**

Newton's laws. Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics- moment of inertia tensor. Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes. Special theory of relativity- Lorentz transformations, relativistic kinematics and mass-energy equivalence. Dynamical systems, Phase space dynamics, stability analysis. Poisson brackets and canonical transformations. Symmetry, invariance and Noether's theorem. Hamilton-Jacobi theory.

**III. Electromagnetic Theory**

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields. Dispersion relations in plasma. Lorentz invariance of Maxwell's equation. Transmission lines and wave guides. Radiation- from moving charges and dipoles and retarded potentials.

**IV. Quantum Mechanics**

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time- independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection. Spin-orbit coupling, fine structure.

WKB approximation. Elementary theory of scattering: phase shifts, partial waves, Born approximation. Relativistic quantum mechanics: Klein-Gordon and Dirac equations. Semi-classical theory of radiation.

#### **V. Thermodynamic and Statistical Physics**

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law. First- and second-order phase transitions. Diamagnetism, paramagnetism, and ferromagnetism. Ising model. Bose-Einstein condensation. Diffusion equation. Random walk and Brownian motion. Introduction to nonequilibrium processes.

#### **VI. Electronics and Experimental Methods**

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters. Microprocessor and microcontroller basics.

Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting, Linear and nonlinear curve fitting, chi-square test. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding. Fourier transforms, lock-in detector, box-car integrator, modulation techniques. High frequency devices (including generators and detectors).

#### **VII. Atomic & Molecular Physics**

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

#### **VIII. Condensed Matter Physics**

Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals.

#### **IX. Nuclear and Particle Physics**

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions.

Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

**X. Miscellaneous general question in basic physics.**

**FACULTY:- SCIENCES**

**DISCIPLINE:- MATHEMATICS**

**SYLLABUS FOR PhD ELIGIBILITY TEST (SECTION I/TECHNICAL SECTION):**

***Ordinary Differential Equations (ODEs):***

Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs. General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function.

***Partial Differential Equations (PDEs):***

Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs. Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations.

***3-Dimensional Geometry and Vector Calculus***

***Laplace and Fourier Transforms***

***Numerical Analysis :***

Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, Finite differences, Lagrange, Hermite and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

***Linear Integral Equations:***

Linear integral equation of the first and second kind of Fredholm and Volterra type, Solutions with separable kernels. Characteristic numbers and eigenfunctions, resolvent kernel.

***Classical Mechanics:***

Generalized coordinates, Lagrange's equations, Hamilton's canonical equations, Hamilton's principle and principle of least action, Two-dimensional motion of rigid bodies, Euler's dynamical equations for the motion of a rigid body about an axis, theory of small oscillations.

**Linear Algebra:** Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Quadratic forms, reduction and classification of quadratic forms

**Algebra:**

Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow theorems.

Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain.

Polynomial rings and irreducibility criteria. Fields, finite fields, field extensions, Galois Theory.

**Topology:** basis, dense sets, subspace and product topology, separation axioms, connectedness and compactness.

**Analysis:** Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral, Improper Integrals.

Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral.

**Complex Analysis**

Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem. Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations.

**Statistics and data analysis**

Sample space, discrete probability, independent events, Bayes theorem. Random variables and distribution functions (univariate and multivariate); expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Probability inequalities (Tchebyshef, Markov, Jensen). Modes of convergence, weak and strong laws of large numbers, Central Limit theorems (i.i.d. case).

Markov chains with finite and countable state space, classification of states, limiting behaviour of n-step transition probabilities, stationary distribution, Poisson and birth-and-death processes.

Standard discrete and continuous univariate distributions. sampling distributions, standard errors and asymptotic distributions, distribution of order statistics and range.

Methods of estimation, properties of estimators, confidence intervals. Tests of hypotheses: most powerful and uniformly most powerful tests, likelihood ratio tests. Analysis of discrete data and chi-square test of goodness of fit. Large sample tests.

Simple random sampling, stratified sampling and systematic sampling. Probability proportional to size sampling. Ratio and regression methods. Completely randomized designs, randomized block designs and Latin-square designs.

**FACULTY:- COMMERCE AND MANAGEMENT**

**DISCIPLINE:- COMMERCE & MANAGEMENT**

**SYLLABUS FOR PhD ENTRANCE TEST (PET) (SECTION I/TECHNICAL SECTION)**

**BUSINESS MANAGEMENT**

Unit 1

- Advertising
- Business Environment
- Capital Budgeting
- Cost-output relations
- Infrastructure- Management and Policy
- Macro –economics
- Managerial Economics- Demand Analysis
- Market structures
- National Income Concepts
- Pricing Theories
- Production Function

Unit – II

- Classical and Modern Theories of Organisational Structure
- Organisational Design
- Organisational Development
- Skills and Roles in an organization



- The concept and significance of organisational behaviour
- Understanding and Managing individual behaviour personality –Attitudes, Learning, Motivation, Perception, Values
- Understanding and Managing Group Behaviour – Communication, Interpersonal and group dynamics, Leadership, Managing change, Managing conflicts, Processes

#### Unit – III

- Human Resource Management ( HRM )- A diagnostic model, External and Internal environment, Forces and Influences, Functions, Objectives, Organizing HRM function, Significance
- Job analysis and Job Evaluation
- Recruitment, Selecting Human Resources- Induction, Training, Development
- Dispute Resolution and Grievance Management
- Exit policy and Implications
- Industrial Relations and Trade Unions
- Labor Welfare and Social Security Measures
- Performance Appraisal and Evaluation
- Career Planning and Development- Career planning and development methods, Concept of career
- Compensation and Benefits- Fringe Benefits, Human resource records and audit, Job evaluation techniques, Wage and salary administration
- Employee Discipline- Causes and forms, Disciplinary action, Domestic enquiry, Importance
- Collective Bargaining – Concept, New trends in collective bargaining, Pre-requisites, Process
- Industrial Democracy and Employee Participation - Employee Participation (Objectives, Forms of Employee Participation)
- Need for industrial democracy, Pre – requisites for industrial democracy
- Future of Human Resource Management

#### Unit – IV

- Nature and Scope of Financial Management
- Capital Budgeting Decisions
- Capital Structure and Cost of Capital
- Pricing Theories
- Dividend Policy
- Financial Management – Nature, Scope
- Long – Term and Short – Term Financing Instruments
- Foreign exchange markets, Determination of exchange rates, Exchange risk measurement
- Mergers and Acquisitions
- Valuation Concepts and Valuation of Securities
- Corporate risk management
- Elements of Derivatives

#### Unit – V

- Marketing - Concept, Different environments and their influences on marketing, Marketing mix, Marketing myopia, Nature and Scope, Understanding the customer and competition
- Marketing Environment - Environment Scanning
- Marketing Information Systems - Marketing Research
- Branding and Packaging

- Demand Measurement and Forecasting
- New Product Development
- Market Segmentation - Targeting and Positioning
- Pricing Methods and Strategies
- Product Decisions
- Product Life Cycle
- Product mix
- Consumer Behaviour theories
- Export Marketing
- Advertising
- Channel Management
- Customer Relation Management
- Evaluation and Control of Marketing Effort
- Marketing of Services
- New issues in Marketing
- Personal Selling
- Uses of Internet as a Marketing Medium
- Wholesaling and Retailing
- Vertical Marketing Systems

Unit – VI

- Demand Forecasting for Operations
- Determinants of Product mix
- Facility Location
- Layout Planning and Analysis
- Production Planning and Control
- Production Scheduling
- Role and Scope of Production Management
- Statistical Quality Control
- Time and Motion Study
- Work measurement
- Decision Theory
- Duality
- Inventory Control
- Linear Programming
- Markov Analysis
- PERT / CPM
- Queuing Theory
- Role and Scope of Operations Research
- Sensitivity Analysis

- Transportation Model

#### Unit – VII

- Correlation and Regression analysis
- Probability Theory
- Probability distributions - Normal and Exponential, Binomial, Poisson
- Sampling theory - Large and small samples, Sampling distributions, t, z, F, Chi – square tests, Tests of Hypothesis
- Use of Computers in Managerial applications- Information systems, Internet and Internet – based applications, MIS and Decision making; System analysis and design, Technology issues and Data processing in organizations, Trends in Information Technology

#### Unit – VIII

- Ansoff's Growth Vector
- BCG Model
- Competitor Analysis
- Components of Strategy Formulation
- Concept of Corporate Strategy
- Industry Analysis
- Porter's Generic Strategies
- Strategic Dimensions and Group Mapping
- Strategies in Industry Evolution- Fragmentation, Maturity, Decline
- Competitive Advantage of Nations
- Competitive strategy and Corporate Strategy
- Global Entry Strategies
- Globalisation of Financial System and Services
- Managing Cultural Diversity
- Managing International Business
- RTP and WTO
- Transnationalization of World Economy

#### Unit – IX

- Competencies and its development
- Detailed business plan preparation
- Innovation and Entrepreneurship
- Managing small enterprises
- Organisational Entrepreneurship
- Planning for growth
- Process of Business Opportunity Identification
- Rehabilitation of Sick Enterprises
- Sickness in Small Enterprises
- Small business

#### Unit – X

- Corporate governance and ethics
- Ecological consciousness
- Environmental ethics
- Ethical issues and Analysis in Management
- Ethical pressure on individual in organizations
- Ethics and Management System
- Gender issues
- Personal framework for ethical choices
- Social responsibilities of business
- Value based organizations

Unit-XI

- Emerging Opportunities for Global Business
- Export promotion policies
- India's Foreign Trade and Policy
- International financial environment - International Financial Management, Mergers and Acquisitions
- International investment - International capital markets, International Credit Rating Agencies, Implications of the ratings
- International marketing logistics - Organization of shipping services, International logistical structures, Marine cargo insurance, Export Documentation framework, Chartering practices
- International Trade Block
- Multilateral Environmental Agreements (MEAs)
- Policy and performance of Export zones
- Technology monitoring
- Trade agreements with other countries
- WTO and Multilateral trade agreements

COMMERCE

Unit-I

Managerial Economics-Demand Analysis Production Function Cost-Output Relations Market Structures Pricing Theories Advertising Macro-Economics National Income Concepts Infrastructure-Management and Policy Business Environment Capital Budgeting

Unit-II

The concept and significance of organisational behaviour-Skills and Roles in an organisation-Classical, Neo-Classical and Modern Theories of Organisational Structure-Organisational Design-Understanding and managing individual behaviour, personality-Perception-Values-Attitudes-Learning-Motivation. Understanding and Managing Group Behaviour, Processes-Inter-personal and group dynamics-Communication-Leadership-Managing change-Managing conflicts. Organisational Development.

Unit-III

Concepts and Perspectives in HRM; HRM in changing environment. Human Resource Planning-Objectives, Process and Techniques. Job analysis-Job Description. Recruitment and Selection, Selecting Human Resources. Induction, Training and Development, Career Planning and Development, Exit policy and Implications. Performance Appraisal and Evaluation. Potential Assessment. Job Evaluation. Wage Determination. Compensation Benefits, Industrial Relations and Trade Unions. Collective Bargaining, Industrial Democracy and Employee Participation, Dispute Resolution and Grievance Management, Labour Welfare and Social Security Measures, Future of Human Resource Management

Unit-IV

Financial Management-Nature and Scope. Valuation Concepts and Valuation of Securities. Capital Budgeting Decisions-Risk Analysis. Capital Structure and Cost of Capital. Understanding Financial Statement and Analysis, Dividend Policy-Theories and Determinants. Long-Term and Short-Term Financing Instruments. Mergers and Acquisitions, Working Capital Management-Determinants

and Financing; Cash management; Inventory management; Receivables management, Elements of Derivatives, Corporate Risk Management, Mergers and Acquisitions, International Financial Management: International Capital Market, ForeignExchange Markets, Determination of Exchange Rates, Exchange Risk Measurement, International Investment.

Unit-V

Marketing – Concept, Nature and Scope, Marketing Myopia, Marketing Mix, Marketing Environment and Environment Scanning; Marketing Information Systems and Marketing Research; Understanding Consumer and Industrial Markets; Demand Measurement and Forecasting; Market Segmentation-Targeting and Positioning; Product Decisions, Product mix, Product Life Cycle; New Product Development; Branding and Packaging; Pricing Methods and Strategies. Promotion Decisions-Promotion Mix; Advertising; Personal Selling; Channel Management; Vertical Marketing Systems; Evaluation and Control of Marketing Effort; Marketing of Services; Customer Relation Management Uses of Internet as a Marketing Medium-Other Related Issues like Branding, Market Development, Advertising and Retailing on the net. New issues in Marketing, Relationship Marketing, Sales Function, Consumer Behaviour Theories and Models, Export Marketing- Indian and Global Context, Test Marketing, Distribution Channels.

Unit-VI

Role and Scope of Production Management; Faculty Location; Layout Planning and Analysis; Production Planning and Control-Production Process Analysis; Demand Forecasting for Operations; Determinants of Product mix; Production Scheduling; Work measurement; Time and Motion Study; Statistical Quality Control. Role and Scope of Operations Research; Linear Programming; Sensitivity Analysis; Duality; Transportation Model; Inventory Control; Queueing Theory; Decision Theory; Markov Analysis; PERT/CPM.

Unit-VII

Probability Theory; Probability distributions-Binomial, Poisson, Normal and Exponential; Correlation and Regression analysis; Sampling theory; Sampling distributions; Tests of Hypothesis; Large and small samples; t z, F, Chi-square tests. Use of Computers in Managerial applications; Technology issues and Data processing in organizations; Information systems; MIS and Decision making; System analysis and design; Trends in Information Technology; Internet and Internet-based applications.

Unit-VIII

Concept of Corporate Strategy; Components of Strategy Formulation; Ansoffs Growth Vector; BCG Model; Porter's Generic Strategies; Competitor Analysis; Strategic Dimensions and Group Mapping; Industry Analysis; Strategies in Industry Evolution, Fragmentation, Maturity, and decline. Competitive strategy and Corporate Strategy; Transnationalization of World Economy; Managing Cultural Diversity; Global Entry Strategies; Globalisation of Financial System and Services; Managing International Business; Competitive Advantage of Nations; RTP and WTO, International Trade Block – NAFTA, ASEA, SAARC, Dispute Settlement Mechanism, International Credit Rating Agencies, Emerging Opportunities in Global Business Indian Foreign Trade and Policy: Export Promotion Policies.

Unit-IX

Concepts-Types, Characteristics; Motivation; Competencies and its development; Innovation and Entrepreneurship; Small business-Concepts Government policy for promotion of small and tiny enterprises; Process of Business Opportunity Identification Detailed business plan preparation; Managing small enterprises; Planning for growth; Sickness in Small Enterprises; Rehabilitation of Sick Enterprises; Intrapreneurship (Organisational Entrepreneurship).

Unit-X

Ethics and Management System; Ethical issues and Analysis in Management; Value based organisations; Personal framework for ethical choices Ethical pressure on individual in organisations; Gender issues; Ecological consciousness; Environmental ethics; Social responsibilities of business; Corporate governance and ethics.

**FACULTY:- ENGINEERING & TECHNOLOGY**

**DISCIPLINE:- MECHANICAL (ME)**

**SYLLABUS FOR PhD ENTRANCE TEST (PET) (SECTION I/TECHNICAL SECTION)**

**ENGINEERING MATHEMATICS**

**Linear Algebra:** Matrix algebra, Systems of linear equations, Eigen values and eigen vectors.

**Calculus:** Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

**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.

**Complex variables:** Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

**Probability and Statistics:** Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

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

#### **APPLIED MECHANICS AND DESIGN**

**Engineering Mechanics:** Free body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion, including impulse and momentum (linear and angular) and energy formulations; impact.

**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; deflection of beams; torsion of circular shafts; Euler's theory of columns; strain energy methods; thermal stresses.

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

**Vibrations:** Free and forced vibration of single degree of freedom systems; effect of damping; vibration isolation; resonance, critical speeds of shafts.

**Design:** Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; *principles* of the design of machine elements such as bolted, riveted and welded joints, shafts, spur gears, rolling and sliding contact bearings, brakes and clutches.

#### **FLUID MECHANICS AND THERMAL SCIENCES**

**Fluid Mechanics:** Fluid properties; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations 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.

**Heat-Transfer:** Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; 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:** Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; Carnot cycle, irreversibility and availability; behaviour 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.

**Applications:** *Power Engineering:* Steam Tables, Rankine, Brayton cycles with regeneration and reheat. *I.C. Engines:* air-standard Otto, Diesel cycles. *Refrigeration and air-conditioning:* Vapour refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle; moist air: psychrometric chart, basic psychrometric processes. *Turbomachinery:* Pelton-wheel, Francis and Kaplan turbines — impulse and reaction principles, velocity diagrams.

#### **MANUFACTURING AND INDUSTRIAL ENGINEERING**

**Engineering Materials:** Structure and properties of engineering materials, heat treatment, stress-strain diagrams for engineering materials.

**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 (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing,

bending) 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, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures

**Metrology and Inspection:** Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

**Computer Integrated Manufacturing:** Basic concepts of CAD/CAM and their integration tools.

**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 duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

FACULTY:- ENGG & TECH

DISCIPLINE:- **Electronics and Communication Engg. (ECE)**

**SYLLABUS FOR PhD ELIGIBILITY TEST (SECTION I/TECHNICAL SECTION):**

**Section 1: Engineering Mathematics**

Linear Algebra: Vector space, basis, linear dependence and independence, matrix algebra, eigen values and eigen vectors, rank, solution of linear equations – existence and uniqueness.

Calculus: Mean value theorems, theorems of integral calculus, evaluation of definite and improper integrals, partial derivatives, maxima and minima, multiple integrals, line, surface and volume integrals, Taylor series.

Differential Equations: First order equations (linear and nonlinear), higher order linear differential equations, Cauchy's and Euler's equations, methods of solution using variation of parameters, complementary function and particular integral, partial differential equations, variable separable method, initial and boundary value problems.

Vector Analysis: Vectors in plane and space, vector operations, gradient, divergence and curl, Gauss's, Green's and Stoke's theorems.

Complex Analysis: Analytic functions, Cauchy's integral theorem, Cauchy's integral formula; Taylor's and Laurent's series, residue theorem.

Numerical Methods: Solution of nonlinear equations, single and multi-step methods for differential equations, convergence criteria.

Probability and Statistics: Mean, median, mode and standard deviation; combinatorial probability, probability distribution functions - binomial, Poisson, exponential and normal; Joint and conditional probability; Correlation and regression analysis.

**Section 2: 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 3: 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 4: 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 op-amp configurations; Function generators, wave-shaping circuits and 555 timers; Voltage reference circuits; Power supplies: ripple removal and regulation.

**Section 5: 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 6: 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 7: 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 8: 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.

**FACULTY:- ENGG & TECH****DISCIPLINE:- ELECTRICAL ENGG. (EE)****SYLLABUS FOR PhD ELIGIBILITY TEST (SECTION I/TECHNICAL SECTION):****Section 1: Engineering Mathematics**

**Linear Algebra:** Matrix Algebra, Systems of linear equations, Eigenvalues, Eigenvectors.

**Calculus:** Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series, Vector identities, Directional derivatives, Line integral, Surface integral, Volume integral, Stokes's theorem, Gauss's theorem, Green's theorem.

**Differential equations:** First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's equation, Euler's equation, Initial and boundary value problems, Partial Differential Equations, Method of separation of variables.

**Complex variables:** Analytic functions, Cauchy's integral theorem, Cauchy's integral formula, Taylor series, Laurent series, Residue theorem, Solution integrals.

**Probability and Statistics:** Sampling theorems, Conditional probability, Mean, Median, Mode, Standard Deviation, Random variables, Discrete and Continuous distributions, Poisson distribution, Normal distribution, Binomial distribution, Correlation analysis, Regression analysis.

**Numerical Methods:** Solutions of nonlinear algebraic equations, Single and Multi-step methods for differential equations.



**Transform Theory:** Fourier Transform, Laplace Transform, z-Transform.

## ***ELECTRICAL ENGINEERING***

### **Section 2: Electric Circuits**

Network graph, KCL, KVL, Node and Mesh analysis, Transient response of dc and ac networks, Sinusoidal steady-state analysis, Resonance, Passive filters, Ideal current and voltage sources, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Two-port networks, Three phase circuits, Power and power factor in ac circuits.

### **Section 3: Electromagnetic Fields**

Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

### **Section 4: 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, Applications of Fourier Transform, Laplace Transform and z-Transform.

### **Section 5: Electrical Machines**

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, parallel operation; Auto-transformer, Electromechanical energy conversion principles, DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control; Operating principle of single phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance, regulation and parallel operation of generators, starting of synchronous motor, characteristics; Types of losses and efficiency calculations of electric machines.

### **Section 6: Power Systems**

Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss-Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

### **Section 7: Control Systems**

Mathematical modeling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, State transition matrix.

### **Section 8: Electrical and Electronic Measurements**

Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multimeters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.

### **Section 9: Analog and Digital Electronics**

Characteristics of diodes, BJT, MOSFET; Simple diode circuits: clipping, clamping, rectifiers; 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, Demultiplexer, Schmitt trigger, Sample and hold circuits, A/D and D/A converters, 8085 Microprocessor: Architecture, Programming and Interfacing.

### **Section 10: Power Electronics**

Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost converters; Single and three phase configuration of uncontrolled rectifiers, Line commutated thyristor based converters, Bidirectional ac to dc voltage source converters, Issues of line current harmonics, Power factor, Distortion factor of ac to dc converters, Single phase and three phase inverters, Sinusoidal pulse width modulation.

**SYLLABUS FOR PhD ELIGIBILITY TEST (SECTION I/TECHNICAL SECTION):****Section 1: Structural Engineering**

**Engineering Mechanics:** System of forces, free-body diagrams, equilibrium equations; Internal forces in structures; Friction and its applications; Kinematics of point mass and rigid body; Centre of mass; Euler's equations of motion; Impulse-momentum; Energy methods; Principles of virtual work.

**Solid Mechanics:** Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Theories of failures; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, buckling of column, combined and direct bending stresses.

**Structural Analysis:** Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis.

**Construction Materials and Management:** Construction Materials: Structural steel - composition, material properties and behaviour; Concrete - constituents, mix design, short-term and long-term properties; Bricks and mortar; Timber; Bitumen. Construction Management: Types of construction projects; Tendering and construction contracts; Rate analysis and standard specifications; Cost estimation; Project planning and network analysis - PERT and CPM.

**Concrete Structures:** Working stress, Limit state and Ultimate load design concepts; Design of beams, slabs, columns; Bond and development length; Prestressed concrete; Analysis of beam sections at transfer and service loads.

**Steel Structures:** Working stress and Limit state design concepts; 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.

**Section 2: Geotechnical Engineering**

**Soil Mechanics:** Origin of soils, soil structure and fabric; Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Darcy's law; Seepage through soils - two-dimensional flow, flow nets, uplift pressure, piping; Principle of effective stress, capillarity, seepage force and quicksand condition; Compaction in laboratory and field conditions; One-dimensional consolidation, time rate of consolidation; Mohr's circle, stress paths, effective and total shear strength parameters, characteristics of clays and sand.

**Foundation Engineering:** Sub-surface investigations - scope, drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and Coulomb; Stability of slopes - finite and infinite slopes, method of slices and Bishop's method; Stress distribution in soils - Boussinesq's and Westergaard's theories, pressure bulbs; Shallow foundations - Terzaghi's and Meyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations - types of piles, dynamic and static formulae, load capacity of piles in sands and clays, pile load test, negative skin friction.

**Section 3: Water Resources Engineering**

**Fluid Mechanics:** Properties of fluids, fluid statics; Continuity, momentum, energy and corresponding equations; Potential flow, applications of momentum and energy equations; Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth.

**Hydraulics:** Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Kinematics of flow, velocity triangles; Basics of hydraulic machines, specific speed of pumps and turbines; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, slope profile, hydraulic jump, uniform flow and gradually varied flow

**Hydrology:** Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, flood estimation and routing, reservoir capacity, reservoir and channel routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's law.

**Irrigation:** Duty, delta, estimation of evapo-transpiration; Crop water requirements; Design of lined and unlined canals, head works, gravity dams and spillways; Design of weirs on permeable foundation;

Types of irrigation systems, irrigation methods; Water logging and drainage; Canal regulatory works, cross-drainage structures, outlets and escapes.

#### **Section 4: Environmental Engineering**

**Water and Waste Water:** Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment. Unit operations and unit processes of domestic wastewater, sludge disposal.

**Air Pollution:** Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

**Municipal Solid Wastes:** Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).

**Noise Pollution:** Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

#### **Section 5: Transportation Engineering**

**Transportation Infrastructure:** Highway alignment and engineering surveys; Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments; Geometric design of railway track; Airport runway length, taxiway and exit taxiway design.

**Highway Pavements:** Highway materials - desirable properties and quality control tests; Design of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible pavement using IRC: 37-2012; Design of rigid pavements using IRC: 58-2011; Distresses in concrete pavements.

**Traffic Engineering:** Traffic studies on flow, speed, travel time - delay and O-D study, PCU, peak hour factor, parking study, accident study and analysis, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Control devices, signal design by Webster's method; Types of intersections and channelization; Highway capacity and level of service of rural highways and urban roads.

#### **Section 6: Geomatics Engineering**

Principles of surveying; Errors and their adjustment; Maps - scale, coordinate system; Distance and angle measurement - Levelling and trigonometric levelling; Traversing and triangulation survey; Total station; Horizontal and vertical curves. Photogrammetry - scale, flying height; Remote sensing - basics, platform and sensors, visual image interpretation; Basics of Geographical information system (GIS) and Geographical Positioning system (GPS).

**FACULTY:- ENGG & TECH**

**DISCIPLINE:- TEXTILE ENGG.**

#### **SYLLABUS FOR PhD ELIGIBILITY TEST (SECTION I/TECHNICAL SECTION):**

##### **Section 1: Textile Fibers**

Classification of textile fibers; Essential requirements of fiber forming polymers; Gross and fine structure of natural fibers like cotton, wool, silk, Introduction to important bast fibres; properties and uses of natural and man-made fibres including carbon, aramid and ultra high molecular weight polyethylene (UHMWPE) fibers; physical and chemical methods of fiber and blend identification and blend analysis.

Molecular architecture, amorphous and crystalline phases, glass transition, plasticization, crystallization, melting, factors affecting T<sub>g</sub> and T<sub>m</sub>; Production process of viscose and other regenerated cellulosic fibres such as polynosic, lyocell. Polymerization of nylon-6, nylon-66, poly (ethylene terephthalate), polyacrylonitrile and polypropylene; Melt Spinning processes for PET, polyamide and polypropylene; Wet and dry spinning processes for viscose and acrylic fibres; post spinning operations such as drawing, heat setting, tow- to-top conversion and different texturing methods.

Methods of investigating fibre structure e.g., Density, X-ray diffraction, birefringence, optical and electron microscopy, I.R. spectroscopy, thermal methods (DSC, DMA/TMA, TGA); structure and morphology of man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

##### **Section 2: Yarn manufacture, Yarn structure and Properties**

Principles of opening, cleaning and mixing/blending of fibrous materials, working principle of modern opening and cleaning equipment; the technology of carding, carding of cotton and synthetic fibres; Drafting operation, roller and apron drafting principle, causes of mass irregularity introduced by drafting; roller arrangements in drafting systems; principles of cotton combing, combing cycle, mechanism and function, combing efficiency, lap preparation; recent developments in comber; Roving production, mechanism of bobbin building, roving twist; Principle of ring spinning, forces acting on yarn and traveler, ring

& traveler designs, mechanism of cop formation, causes of end breakages; Working principle of ring doubler and two for one twister, single and folded yarn twist, properties of double yarns, production of core spun yarn; Principles of compact, rotor, air jet, air vortex, core, wrap, twist less and friction spinning.

Yarn contraction, yarn diameter, specific volume & packing coefficient; Twist factor, twist strength relationship in spun yarns; Fibre configuration and orientation in yarn; Cause of fibre migration and its estimation; Irregularity index; Structure property relationship of compact ring, rotor, air-jet and friction spun yarns.

### **Section 3: Fabric manufacture, Structure and Properties**

Principles of winding processes and machines, random, precision and step precision winding, package faults and their remedies; Yarn clearers and tensioners; Different systems of yarn splicing; Features of modern cone winding machines; Different types of warping creels; features of modern beam and sectional warping machines; Different sizing systems, sizing of spun and filament yarns, sizing machines; Principles of pilm winding processes and machines.

Primary and secondary motions of loom, cam design & kinematics of sley, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; Dobby and jacquard shedding; Mechanics of weft insertion with shuttle, warp and weft stop motions, warp protection, weft replenishment; Principles of weft insertion systems of shuttle-less weaving machines; Principles of multiphase and circular looms.

Principles of weft and warp knitting, basic weft and warp knitted structures; Classification, production, properties and application of nonwoven fabrics, principle of web formation & bonding.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, leno and double cloth constructions. Peirce's equations for fabric geometry; elastica model of plain woven fabrics; thickness, cover and maximum set of woven fabrics.

### **Section 4: Textile Testing**

Sampling techniques, sample size and sampling errors; Measurement of fibre length, fineness, crimp; measurement of cotton fiber maturity and trash content; High volume fibre testing; Measurement of yarn count, twist and hairiness; Tensile testing of fibers, yarns and fabrics; Evenness testing of slivers, rovings and yarns; Classimat fault analysis; Testing equipment for measurement of fabric properties like thickness, compressibility, air permeability, wetting & wicking, drape, crease recovery, tear strength, bursting strength and abrasion resistance; Instruments and systems for objective evaluation of fabric hand. Statistical analysis of experimental results, frequency distributions, correlation, significance tests, analysis of variance and control charts.

### **Section 5: Chemical processing**

Impurities in natural fibre; Chemistry and practice of preparatory processes for cotton, wool and silk; Mercerization of cotton; Preparatory processes for manmade fibres and their blends.

Classification of dyes; Dyeing of cotton, wool, silk, polyester, nylon and acrylic with appropriate dye classes; Dyeing of polyester/cotton and polyester/wool blends; Dyeing machines; Dyeing of cotton knitted fabrics and machines used; Dyefibre interaction; Introduction to thermodynamics and kinetics of dyeing; Methods for determination of wash, light and rubbing fastness.

Styles of printing; Printing thickeners including synthetic thickeners; Printing auxiliaries; Printing of cotton with reactive dyes, wool, silk, nylon with acid and metal complex dyes, Printing of polyester with disperse dyes; Pigment printing; Resist and discharge printing of cotton, silk and polyester; Transfer printing of polyester; Inkjet printing.

Mechanical finishing of cotton. Stiff, soft, wrinkle resistant, water repellent, flame retardant and enzyme (bio-polishing) finishing of cotton; Milling, decatizing and shrink resistant finishing of wool; Antistatic and soil release finishing; Heat setting of synthetic fabrics; Minimum application techniques; Pollution control and treatment of effluents.

**FACULTY:- PHARMACY**

**DISCIPLINE:- PHARMACY**

### **SYLLABUS FOR PhD ELIGIBILITY TEST (SECTION I/TECHNICAL SECTION):**

#### **PHARMACEUTICS**

#### **Introduction to Physical pharmacy**

##### Matter, Properties of Matter:

State of matter, change in the state of matter, latent heats and vapor pressure, sublimation critical point, Eutectic mixtures, gases, aerosols-inhalers, relative humidity, liquid. Complexes, liquid crystals, glassy state, solids- crystalline, amorphous and polymorphism.

##### Micromeritics and Powder Rheology:

Particle size and distribution, average particle size, number and weight distribution, particle number, methods for determining particle volume, methods of determining particle size- optical microscopy, sieving, sedimentation; measurements of particle shape, specific surface area; methods for determining surface area; permeability, adsorption, derived properties of powders, porosity, packing arrangement, densities, bulkiness & flow properties.

Surface and Interfacial Phenomenon:

Liquid interface, surface and interfacial tensions, surface free energy, measurement of surface and interfacial tensions, spreading coefficient, adsorption at liquid interfaces, surface active agents, HLB classification, solubilization, detergency, adsorption at solid interfaces, solid-gas and solid-liquid interfaces, complex films, electrical properties of interface.

Viscosity and Rheology:

Newtonian systems, Law of flow, kinematic viscosity, effect of temperature; non-Newtonian systems: pseudoplastic, dilatant, plastic; thixotropy, thixotropy in formulation, negative thixotropy, determination of viscosity, capillary, falling ball, rotational viscometers.

Dispersion Systems:

Colloidal dispersions: Definition, types, properties of colloids, protective colloids, applications of colloids in pharmacy; Suspensions and Emulsions: Interfacial properties of suspended particles, settling in suspensions, theory of sedimentation, effect of Brownian motion, sedimentation of flocculated particles, sedimentation parameters, wetting of particles, controlled flocculation, flocculation in structured vehicles, rheological considerations; Emulsions-types, theories, physical stability.

Complexation:

Classification of complexes, methods of preparation, analysis, & applications.

Kinetics and Drug Stability:

General considerations & concepts, half-life determination, Influence of temperature, light, solvent, catalytic species and other factors, Accelerated stability study, expiration dating.

**Dispensing and community pharmacy**

Prescription:

Handling of prescription, source of errors in prescription, care required in dispensing procedures including labeling of dispensed products. General dispensing procedures including labeling of dispensed products; Pharmaceutical calculations: Posology, calculation of doses for infants, adults and elderly patients; Enlarging and reducing recipes percentage solutions, alligation, alcohol dilution, proof spirit, isotonic solutions, displacement value etc.

Community Pharmacy:

Organization and structure of retail and whole sale drug store-types of drug store and design, legal requirements for establishment, maintenance and drug store-dispensing of proprietary products, maintenance of records of retail and wholesale, patient counseling, role of pharmacist in community health care and education (First aid, communicable diseases, nutrition, family planning).

Drug Information Services:

Sources' of Information on drugs, disease, treatment schedules, procurement of information, Computerized services (e.g., MEDLINE), Retrieval of information, Medication error- types of medication errors, correction and reporting.

**Dosages Forms, designing & evaluation**

Liquid Dosages Forms:

Introduction, types of additives used in formulations, vehicles, stabilizers, preservatives, suspending agents, emulsifying agents, solubilizers, colors, flavors and others, manufacturing packaging, labeling, evaluation of clear liquids, suspensions and emulsions official in pharmacopoeia;

Semisolid Dosage Forms:

Definitions, types, mechanisms of drug penetration, factors influencing penetration, semisolid bases and their selection. General formulation of semisolids, clear gels manufacturing procedure, evaluation and packaging.

Suppositories:

Ideal requirements, bases, displacement value, manufacturing procedure, packaging and evaluation;

Extraction and Galenical Products:

Principle and method of extraction, preparation of infusion, tinctures, dry and soft liquid extracts;

Blood Products and Plasma Substitutes:

Collection, processing and storage of whole human blood, concentrated human RBCs, dried human plasma, human fibrinogen, human thrombin, human normal immunoglobulin, human fibrin, foam plasma substitutes, -ideal requirements, PVP, dextran Etc. for control of blood pressure as per I.P.;

Pharmaceutical Aerosols:

Definition, propellants, general formulation, manufacturing' and packaging methods, pharmaceutical applications;

Ophthalmic Preparations:

Requirements, formulation, methods of preparation, labeling, containers, evaluation;

Cosmeticology and Cosmetic Preparations:

Fundamentals of cosmetic science, structure and functions of skin and hair. Formulation, preparation and packaging of cosmetics for skin, hair, dentifrice and manicure preparations like nail polish, nail polish remover, Lipsticks, eye lashes, baby care products Etc.

Capsules:

Advantages and disadvantages of capsule dosage form, material for production of hard gelatin capsules, size of capsules, formulation, method of capsule filling, soft gelatin, capsule shell and capsule content, importance of base absorption and minimum/gm factors in soft capsules, quality control, stability testing and storage of capsule dosage forms.

Micro-encapsulation:

Types of microcapsules, importance of microencapsulation in pharmacy, microencapsulation by phase separation, coacervation, multi-orifice, spray drying, spray congealing, polymerization complex emulsion, air suspension technique, coating pan and other techniques, evaluation of micro capsules.

Tablets:

Advantages and disadvantages of tablets, Application of different types of tablets, Formulation of different types of tablets, granulation, technology on large-scale by various techniques, different types of tablet compression machinery and the equipments employed, evaluation of tablets.

Coating of Tablets:

Types of coating, film forming materials, formulation of coating solution, equipments for coating, coating process, evaluation of coated tablets. Stability kinetics and quality assurance.

Parenteral Products:

Pre-formulation factors, routes of administration, water for injection, and sterile water for injection, pyrogenicity, non- aqueous vehicles, isotonicity and methods of its adjustment, Formulation details, Containers and closures and selection, labeling; Pre-filling treatment, washing of containers and closures, preparation of solution and suspensions, filling and closing of ampoules, vials, infusion fluids, lyophilization & preparation of sterile powders, equipment for large scale manufacture and evaluation of parenteral products; Aseptic Techniques-source of contamination and methods of prevention, Design of aseptic area, Laminar flow bench services and maintenance. Sterility testing of pharmaceuticals.

Packaging of Pharmaceutical Products:

Packaging components, types, specifications and methods of evaluation, stability aspects of packaging. Packaging equipments, factors influence choice of containers, legal and official requirements for containers, package testing.

Designing of dosage forms:

Pre-formulation studies, Study of physical properties of drug like physical form, particle size, shape, density, wetting, dielectric constant. Solubility, dissolution and organoleptic properties and their effect on formulation, stability and bioavailability. Study of chemical properties of drugs like hydrolysis, oxidation, reduction, racemization, polymerization etc., and their influence on formulation and stability of products. Study of pro-drugs in solving problems related to stability, bioavailability and elegance of formulations. Design, development and process validation methods for pharmaceutical operations involved in the production of pharmaceutical products with special reference to tablets, suspensions. Stabilization and stability testing protocol for various pharmaceutical products. ICH Guidelines for stability testing of formulations.

Performance evaluation methods:

In-vitro dissolution studies for solid dosage forms methods, interpretation of dissolution data. Bioavailability studies and bioavailability testing protocol and procedures. In vivo methods of evaluation and statistical treatment. GMP and quality assurance, Quality audit. Design, development, production and evaluation of controlled/sustained/extended release formulations.

**Biopharmaceutics & Pharmacokinetics**

Introduction to biopharmaceutics:

Passage of drugs across biological barrier (passive diffusion, active transport, facilitated diffusion, ion-pair formation and pinocytosis); Factors influencing absorption- biological, physico-chemical, physiological and pharmaceutical; Drug distribution in the body, plasma protein binding.

Pharmacokinetics:

Significance of plasma drug concentration measurement. Compartment model- Definition and Scope. Pharmacokinetics of drug absorption - Zero order and first order absorption rate constant using Wagner-Nelson and residual methods. Volume of distribution and distribution coefficient. Compartment kinetics- One compartment and two compartment models. Determination of pharmacokinetic parameters from plasma and urine data after drug administration by intravascular and oral route. Clearance concept, mechanism of renal clearance, clearance ratio, determination of renal clearance. Extraction ratio, hepatic clearance, biliary excretion, extrahepatic circulation. Non-linear pharmacokinetics with special reference to one compartment model after I.V. drug administration.

Clinical Pharmacokinetics:

Definition and scope: Dosage adjustment in patients with and without renal and hepatic failure; Design of single dose bio-equivalence study and relevant statistics; Pharmacokinetic drug interactions and their significance in combination therapy.

Bioavailability and bioequivalence:

Measures of bioavailability, C<sub>max</sub>, t<sub>max</sub>, K<sub>el</sub> and Area Under the Curve (AUC); Design of single dose bioequivalence study and relevant statistics; Review of regulatory requirements for

conducting bioequivalent studies. Biopharmaceutical Classification System (BCS) of drugs.

## PHARMACEUTICAL CHEMISTRY

### Physical Chemistry and its importance in pharmacy

- Importance of basic fundamentals of physical chemistry in pharmacy: of Gases, Kinetic theory of gases, deviation from ideal behavior and explanation.
- The Liquid State: Physical properties (surface tension, parachor, viscosity, refractive index, dipole moment);
- Solutions: Ideal and real solutions, solutions of gases in liquids, colligative properties, partition coefficient, conductance and its measurement, Debye Huckel theory;
- Thermodynamics: First, Second and Third laws, Zeroth law, Concept of free energy, enthalpy and entropy, absolute temperature scale;
- Thermochemical equations; Phase rule; Adsorption: Freundlich and Gibbs adsorption, isotherms, Langmuir's theory of adsorption.
- Photochemistry: Consequences of light absorption, Jabolenski diagram, Quantum efficiency; Chemical
- Kinetics: Zero, First and Second order reactions, complex reactions, theories of reaction kinetics, characteristics of homogeneous and heterogeneous catalysis, acid base and enzyme catalysis;
- Quantum Mechanics: Postulates of quantum mechanics, operators in quantum mechanics, the Schrodinger wave equation.

### Organic Chemistry and its importance in pharmacy

Importance of fundamentals of organic chemistry in pharmaceutical sciences; Structure and Properties:

Atomic structure, Atomic orbitals, Molecular orbital theory, wave equation, Molecular orbitals, Bonding and Anti-bonding orbitals, Covalent bond, Hybrid orbitals, Intramolecular forces, Bond dissociation energy, Polarity of bonds, Polarity of molecules, Structure and physical properties, Intermolecular forces, Acids and bases;

- Stereochemistry: Nomenclature, isomerism, stereoisomerism, conformational and configurational isomerism, optical activity, specification of configuration, Reactions involving stereoisomers, chirality, conformations;

Stereoselective and stereospecific reactions; Structure, Nomenclature, Preparation and Reactions of:

Alkanes, Alkenes, Alkynes, Cyclic analogs, Dienes, Benzene, Polynuclear aromatic compounds, Arenes, Alkyl halides, Alcohols, Ethers, Epoxides, Amines, Phenols, Aldehydes and ketones, Carboxylic acids, Functional derivatives of carboxylic acids,  $\alpha,\beta$ -Unsaturated carbonyl compounds, Reactive intermediates- carbocations, carbanions, carbenes and nitrenes;

- Nucleophilic and Electrophilic Aromatic Substitution Reactions:

Reactivity and orientation; Electrophilic and Nucleophilic Addition Reactions; Rearrangements (Beckman, Hoffman, Benzilic acid, pinacole-pinacolone and Bayer-Villager).

- Elimination reactions; Conservation of Orbital Symmetry and Rules: Electrocyclic, Cycloaddition and Sigmatropic reactions;

Neighboring group effects; Catalysis by transition metal complexes; Heterocyclic Compounds:

Nomenclature, preparation, properties and reactions of 3, 4, 5, 6 & 7-membered heterocycles with one or two heteroatoms like O, N, S. Chemistry of lipids, Carbohydrates and Proteins.



## **Biochemistry**

Enzymes: Nomenclature, enzyme kinetics and their mechanism of action, mechanism of inhibition, enzymes and iso-enzymes in clinical diagnosis.

Co-enzymes: Vitamins as co-enzymes and their significance. Metals as cofactors and their significance.

## **Medicinal Chemistry**

Basic Principles:

Physico-chemical and stereoisomeric (Optical, geometrical) aspects of drug molecules and biological action, Bioisosterism, Drug-receptor interactions including transduction mechanisms;

Drug metabolism and Concept of Prodrugs; Principles of Drug Design (Theoretical Aspects):

Traditional analog and mechanism based approaches, QSAR approaches, Applications of quantum mechanics, Computer Aided Drug Designing (CADD) and molecular modeling.

Synthetic Procedures, Mode of Action, Uses, Structure Activity Relationships including Physicochemical Properties of the Following Classes of Drugs:

Drugs acting at synaptic and neuro-effector junction sites: Cholinergics, anti-cholinergics and cholinesterase inhibitors, Adrenergic drugs, Antispasmodic and anti-ulcer drugs, Local Anesthetics, Neuromuscular blocking agents.

Autacoids: Antihistamines, Eicosanoids, Analgesic-antipyretics, Anti-inflammatory (non-steroidal) agents.

Steroidal Drugs: Steroidal nomenclature (IUPAC) and stereochemistry, Androgens and anabolic agents, Estrogens and Progestational agents, Oral contraceptives, Adrenocorticoids;

Drugs acting on the central nervous system:

General Anesthetics, Hypnotics and Sedatives, Anticonvulsants, Anti-Parkinsonian drugs, Psychopharmacological agents (Neuroleptics, Anti-depressants, Anxiolytics), Opioid analgesics, Anti-tussives, CNS stimulants.

Diuretics; Cardiovascular drugs:

Anti-hypertensives, Anti-arrhythmic agents, anti-anginal agents, Cardiotonics, Anti-hyperlipidemic agents, Anticoagulants and Anti-platelet drugs.

Thyroid and Anti thyroid drugs; Insulin and oral hypoglycemic agents:

Chemotherapeutic Agents used in bacterial, fungal, viral, protozoal, parasitic and other infections, Antibiotics:  $\beta$ -Lactam, macrolides, tetracyclines, aminoglycosides, polypeptide antibiotics, fluoroquinolones, Anti-metabolites (including sulfonamides); Anti-neoplastic agents; Anti-viral agents (including anti-HIV); Immunosuppressives and immunostimulants; Diagnostic agents; Pharmaceutical Aids.

Microbial Transformations:

Introduction, types of reactions mediated by micro-organisms, design of biotransformation processes, selection of organisms, biotransformation process and its improvements with special reference to steroids.

Enzyme Immobilization:

Techniques of immobilization, factors affecting enzyme kinetics, Study of enzymes such as hyaluronidase, penicillinase, streptokinase, amylases and proteases, Immobilization of bacteria and

plant cells.

### **Pharmaceutical Analysis**

#### *Different techniques of pharmaceutical analysis, Preliminaries and definitions:*

Significant figures, Rules for retaining significant digits, Types of errors, Mean deviation, Standard deviation, Statistical treatment of small data sets, Selection of sample, Precision and accuracy.

*Fundamentals of volumetric analysis:* Methods of expressing concentration, primary and secondary standards.

*Acid Base Titrations:*

Acid base concepts, Role of solvents, Relative strengths of acids and bases, Ionization, Law of mass action, Common ion effect, Ionic product of water, pH, Hydrolysis of salts, Henderson-Hasselbach equation, Buffer solutions, Neutralization curves, Acid-base indicators, Theory of indicators, Choice of indicators, Mixed indicators, Polyprotic systems, Polyamine and amino acid systems, Amino acid titrations.

*Oxidation Reduction Titrations:*

Concepts of oxidation and reduction, Redox reactions, Strengths and equivalent weights of oxidizing and reducing agents, Theory of redox titrations, Redox indicators, Cell representations, Measurement of electrode potential, Oxidation-reduction curves, Iodimetry and Iodometry, Titrations involving ceric ammonium sulphate, potassium iodate, potassium bromate, potassium permanganate, titanous chloride, stannous chloride and Sodium 2,6-dichlorophenolindophenol.

*Precipitation Titrations:*

Precipitation reactions, Solubility product, Effect of acids, temperature and solvent upon the solubility of a precipitate, Argentometric titrations and titrations involving ammonium or potassium thiocyanate, mercuric nitrate, and barium sulphate, indicators, Methods of end point determination (Gay-Lussac method, Mohr's method, Volhard's method and Fajan's method).

*Non-aqueous titrations:*

Acidic and basic drugs, Solvents used, Indicators.

*Complexometric titrations:*

Complexing agents used as titrants, Indicators, Masking and demasking;

*Miscellaneous Methods of Analysis:*

Diazotization titrations, Kjeldahl method of nitrogen estimation, Karl-Fischer aquametry, Oxygen flask combustion method, Gasometry.

*Chromatography:*

Theory of chromatography, plate theory, Factors affecting resolution, van Deemter equation. The following chromatographic techniques (including instrumentation) with relevant examples of Pharmacoepoel products: TLC, HPLC, GLC, HPTLC, Paper Chromatography and Column Chromatography.

*The Theoretical Aspects, Basic Instrumentation, Elements of Interpretation of Spectra, and Applications (quantitative and qualitative) of the Following Analytical Techniques:*

Ultraviolet and visible spectrophotometry, Fluorimetry, Infrared spectrophotometry, Nuclear Magnetic Resonance spectroscopy [proton technique only], Mass Spectrometry (EI & CI only), Flame Photometry, Atomic Absorption Spectroscopy, X-ray Diffraction Analysis, Radioimmunoassay.

Quality assurance:

GLP, ISO 9000, TQM, Quality Review and Quality documentation, Regulatory control, regulatory drug analysis, interpretation of analytical data, Validation, quality audit: quality of equipment, validation of equipment, validation of analytical procedures.

**PHARMACOLOGY**

Fundamentals of general pharmacology:

Dosage forms and routes of administration, mechanism of action, combined effect of drugs, factors modifying drug action, tolerance and dependence; Pharmacogenetics; Principles of Basic and Clinical pharmacokinetics, absorption, Distribution, Metabolism and Excretion of drugs, Adverse Drug Reactions; Bioassay of Drugs and Biological Standardization; Discovery and development of new drugs, Bioavailability and bioequivalence studies;

Pharmacology of Peripheral Nervous System:

Neurohumoral transmission (autonomic and somatic), Parasympathomimetics, Parasympatholytics, Sympathomimetics, Adrenergic receptor and neuron blocking agents, Ganglion stimulants and blocking agents, Neuromuscular blocking Agents, Local anesthetic Agents.

Pharmacology of Central Nervous System:

Neurohumoral transmission in the C.N.S., General Anesthetics, Alcohols and disulfiram, Sedatives, Hypnotics, Anti-anxiety agents and Centrally acting muscle relaxants, Psychopharmacological agents (anti-psychotics), anti-maniacs, and hallucinogens, Antidepressants, Anti-epileptics drugs, Anti-Parkinsonian drugs, Analgesics, Antipyretics, Narcotic analgesics and antagonists, C.N.S. stimulants, Drug Addiction and Drug Abuse.

Pharmacology of Cardiovascular System:

Drugs used in the management of congestive cardiac failure, Antihypertensive drugs, Anti-anginal and Vasodilator drugs, including calcium channel blockers and beta adrenergic antagonists, Anti-arrhythmic drugs, Anti-hyperlipidemic drugs, Drugs used in the therapy of shock.

Drugs Acting on the Hemopoietic System:

Hematinics, Anticoagulants, Vitamin K and hemostatic agents, Fibrinolytic and anti-platelet drugs, Blood and plasma volume expanders.

Drugs acting on urinary system:

Fluid and electrolyte balance, Diuretics.

Basic Concepts of Pharmacotherapy:

Clinical Pharmacokinetics and individualization of Drug therapy, Drug delivery systems and their Biopharmaceutics & Therapeutic considerations, Drugs used during infancy and in the elderly persons (Pediatrics & Geriatrics), Drugs used during pregnancy, Drug induced diseases, The basics of drug interactions, General principles of clinical toxicology, Common clinical laboratory tests and their interpretation.

Important Disorders of Organs, Systems and their Management: Cardio-vascular disorders- Hypertension, Congestive heart failure, Angina, Acute myocardial infarction, Cardiac arrhythmias.

CNS Disorders: Epilepsy, Parkinsonism, Schizophrenia, Depression.

Respiratory disease- Asthma.

- Gastrointestinal Disorders- Peptic ulcer, Ulcerative colitis, Hepatitis, Cirrhosis.
- Endocrine Disorders- Diabetes mellitus and Thyroid disorders.
- Infectious Diseases- Tuberculosis, Urinary tract infections, Enteric infections, Upper respiratory infections. Hematopoietic Disorders- Anemias,
- Joint and Connective tissue disorders- Rheumatic diseases, Gout and Hyperuricemia.
- Neoplastic Diseases- Acute Leukaemias, Hodgkin's disease. Therapeutic Drug Monitoring, Concept of Essential Drugs and Rational Drug use.

### **PHARMACOGNOSY**

- Sources of Drugs: Biological, marine, mineral and plant tissue cultures as sources of drugs;
- Classification of Drugs: Morphological, taxonomical, chemical and pharmacological classification of drugs;
- Quality Control of Crude Drugs: Adulteration of crude drugs and their detection by organoleptic, microscopic, physical, chemical and biological methods and properties.
- Introduction to Active Constituents of Drugs: Their isolation, classification and properties.

### **Systematic Pharmacognostic study of the followings:**

- Carbohydrates and derived products: agar, guar gum acacia, Honey, Isabgol, pectin, Starch, sterculia and Tragacanth.
- Lipids: Bees wax, Castor oil, Cocoa butter, Codliver oil, Hydnocarpus oil, Kokum butter, Lard, Linseed oil, Rice Bran oil, Shark liver oil and Wool fat.
- Resins: Study of Drugs Containing Resins and Resin Combinations like Colophony, podophyllum, jalap, cannabis, capsicum, myrrh, asafoetida, balsam of Tolu, balsam of Peru, benzoin, turmeric, ginger.
- Tannins: Study of tannins and tannin containing drugs like Gambier, black catechu, gall and myrobalan.
- Volatile Oils: General methods of obtaining volatile oils from plants, Study of volatile oils of Mentha, Coriander, Cinnamon, Cassia, Lemon peel, Orange peel, Lemon grass, Citronella, Caraway, Dill, Spearmint, Clove, Fennel, Nutmeg, Eucalyptus, Chenopodium, Cardamom, Valerian, Musk, Palmarosa, Gaultheria, Sandal wood;
- Phytochemical Screening: Preparation of extracts, Screening of alkaloids, saponins, cardenolides and bufadienolides, flavonoids and leucoanthocyanidins, tannins and polyphenols, anthraquinones, cynogenetic glycosides, amino acids in plant extracts.

**Study of the biological sources, cultivation, collection, commercial varieties, chemical constituents, substitutes, adulterants, uses, diagnostic macroscopic and microscopic features and specific chemical tests of following groups of drugs.**

### **GLYCOSIDE CONTAINING DRUGS:**

- Saponins* : Liquorice, ginseng, dioscorea, sarsaparilla, and senega.
- Cardioactive glycosides*: Digitalis, squill, strophanthus and thevetia,
- Anthraquinone cathartics*: Aloe, senna, rhubarb and cascara,
- Others*: Psoralea, gentian, saffron, chirata, quassia.

**ALKALOID CONTAINING DRUGS:**

- Pyridine-piperidine*: Tobacco, areca and lobelia.
- Tropane*: Belladonna, hyoscyamus, datura, duboisia, coca and withania.
- Quinoline and Isoquinoline*: Cinchona, ipecac, opium.
- Indole*: Ergot, rauwolfia, catharanthus, nux-vomica and physostigma.
- Imidazole*: Pilocarpus.
- Steroid*: Veratrum and kurchi.
- Alkaloidal Amine*: Ephedra and colchicum.
- Glycoalkaloid*: Solanum.
- Purines*:

Coffee, tea and cola. Biological sources, preparation, identification tests and uses of the following enzymes: Diastase, papain, pepsin, trypsin, pancreatin.

**General Techniques of Biosynthetic Studies and Basic Metabolic Pathways/Biogenesis:**

Brief introduction to biogenesis of secondary metabolites of pharmaceutical importance.

- Terpenes*: Monoterpenes, sesquiterpenes, diterpenes, and triterpenoids.
- Carotenoids*: a-carotenoids, β-carotenes, vitamin A, Xanthophylls of medicinal importance.
- Glycosides*: Digitoxin, digoxin, hecogenin, sennosides, diosgenin and sarasapogenin.
- Alkaloids*: Atropine and related compounds, Quinine, Reserpine, Morphine, Papaverine, Ephedrine, Ergot and Vinca alkaloids.

*Lignans, quassanoids and flavonoids.*

- Plant Tissue Culture*:

Historical development of plant tissue culture, types of cultures, nutritional requirements, growth and their maintenance. Applications of plant tissue culture in pharmacognosy.

**FACULTY:- ENGG & TECH**

**DISCIPLINE:- COMPUTER SCIENCE ENGG. (CSE)**

**SYLLABUS FOR PhD ELIGIBILITY TEST (SECTION I/TECHNICAL SECTION):**

**Mathematical Logic:** Propositional Logic; First Order Logic.

**Probability:** Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

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

**Combinatorics:** Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

**Graph Theory:** Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

**Digital Logic:** Logic functions, Minimization, Design and synthesis of combinational and sequential circuits; Number representation and computer arithmetic (fixed and floating point).

**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.

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

**Algorithms:** Analysis, Asymptotic notation, Notions of space and time complexity, Worst and average case analysis; Design: Greedy approach, Dynamic programming, Divide-and-conquer; Tree and

graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching. Asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, Basic concepts of complexity classes P, NP, NP-hard, NP-complete.

**Theory of Computation:** Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Undecidability.

**Compiler Design:** Lexical analysis, Parsing, Syntax directed translation, Runtime environments, Intermediate and target code generation, Basics of code optimization.

**Operating System:** Processes, Threads, Inter-process communication, Concurrency, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security.

**Databases:** ER-model, Relational model (relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B and B+ trees), Transactions and concurrency control.

**Computer Networks:** ISO/OSI stack, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IP(v4), Application layer protocols (ICMP, DNS, SMTP, POP, FTP, HTTP); Basic concepts of hubs, switches, gateways, and routers. Network security basic concepts of public key and private key cryptography, digital signature, firewalls.