8. Ph.D. PROGRAMME

Mode of Program: Regular

8.1 ELIGIBILITY

i. A candidate seeking admission to the degree of Doctor of Philosophy must have obtained M.E./M.Tech./M.Phil./MCA/M.Sc./M.Com/M.Pharma/M.A./M.B.A./C.A. or equivalent with minimum CGPA of 6.00 on a 10-point scale or 60% marks in aggregate where marks are awarded **OR** GATE/GPAT/NET(UGC/CSIR) qualified.

ii. Candidates with B.E./B.Tech./B.Pharma degree or equivalent with excellent academic record (minimum CGPA of 9.00 on 10-point scale or 80% marks in aggregate) may be considered for admission.

Relaxation in CGPA to 7.00 on a 10-point scale or in marks to 65% for the minimum eligibility conditions may be permitted for candidates with a B.E./B.Tech. degree or equivalent who have a minimum of 3 years of professional and/or research experience in the area in which the admission is sought. However, candidates admitted with B.E./B.Tech. or equivalent qualification will be admitted for Ph.D. after successful completion of **eight Masters level courses** as suggested by the Ph.D. Admission Committee of concerned Department/School, within a period of two years from the date of admission. A minimum CGPA of 6.00 on a 10-point scale should be earned in the courses prescribed by the concerned Department/School.

iii. Part-time studies leading to PhD degree are permitted for TIET employees only with the prior approval. Part-time studies leading to PhD shall also be permitted to persons working in Institutions with which a Memorandum of Understanding has been signed for research purposes. Such a candidate must be in employment at the time of admission and be engaged in professional work in the area to which admission is sought.

iv. **Admission of a Ph.D. candidate in a Department/School other than his/her basic background:** Suitability of a candidate is the purview of admission committee, if a candidate qualifies the test and interview then he/she should be allowed to pursue Ph.D. Programme. However, the admission committee may recommend additional courses for the candidate to clear.

v. Candidates shall be admitted on the basis of merit of Entrance Test and Interview to be conducted by the Institute. **The candidates who secure minimum of 50% (45% for SC/ST) marks in the written exam shall only be called for Interview.** During interview, a candidate is required to indicate area of research.

Relaxation for appearing in the entrance test will be given by the institute to those candidates who have qualified NET (UGC/CSIR) or GATE/GPAT (GATE/GPAT score should be valid at the time of admission).

vi. Every admitted candidate shall have to do course work for a minimum of one semester. The course work shall include at least three courses, namely, a course on research methodology (may include quantitative methods and computer applications) or a course proposed by the Admission Committee (for those who have studied a similar course on Research Methodology at PG level), a professional course (if not offered by any Department/ School, its syllabus to be proposed by the

allocated supervisor and approved by DoAA) and a seminar (Relevant in the area of research). Minimum credits for the course work shall be 11 including a seminar of 4 credits. The process of registration in the course work, examination, evaluation and grading shall be same as followed for UG/PG programmes.

Only those candidates who successfully complete the course work within one year of admission and with a minimum CGPA of 6.00 on 10.00-point scale shall be registered in the Ph.D. programme.

Every candidate will be required to submit research proposal, duly recommended by the Supervisor(s), after successful completion of the course work (December 31 shall be taken as date of completion of course work for odd semester and June 30 shall be taken as date of completion for even semester). The minimum time period to submit the research proposal shall be **one semester** from the date of admission **and maximum time allowed to submit the research proposal shall be one year from the date of admission.**

Research proposal will be submitted to the concerned Head of the Department/School. In case of non-submission of proposal within one year, DoRSP on the recommendations of the Supervisor and Head of the Department/School may grant an extension for a maximum period of six months.

If the candidate fails to submit the proposal even during the extended period, her/his admission will be cancelled. In case the proposal is rejected by the IRB, the candidate may resubmit it within next six months starting from the date of meeting of IRB, failing which her/his admission will be cancelled.

NOTE: In case of FN candidates, Research VISA endorsed to TIET is required.

8.2 GENERAL INFORMATION

TIET offers Ph.D. programme in almost all specializations of Engineering, Technology, Management and Sciences in the following Departments/Schools of the Institute (currently around **800** Ph.D. candidates are working for their Ph.D. degrees in the Institute).

Department/School	Specialization
BIOTECHNOLOGY	Biosensors
	Biopolymer
	Molecular Biology
	Microbiology
	Plant Molicular Biology
	Plant Biotechnology
	Epigenomics
	Genomics
	Food Processing
	Medical Biotech
CHEMICAL ENGINEERING	Heat Power
	Energy Management
	Heat Transfer and Hydrodynamics in Nanofluids

Department/School	Specialization
	Thermodynamic & Interfacial Properties of Nanoconfined Fluids
	Polymers–Composites
	Polymers Coatings & Thin Film
	Biodegradable Polymer
	Graphene
	CO2 Capture and Utilization
	Modeling & Simulation
	Process Design
	Catalysis
	Adsorption and Electro Catalytic Oxidation
	Waste Water Treatment
	Pollution abatement
	Separation Process
	Computational Fluid Dynamics(CFD)
CIVIL ENGINEERING	Repair and Retrofitting of Structures
	Sustainable construction materials
	Structural Health Monitoring
	Water Resources Management
	Hydraulic Engineering / Water Resources Engineering
	Pavement Engineering
	Geotechnical Engineering
	FRP structures, strengthening of structures, and use of agriculture and industrial waste in concrete
	Seismic Fragility and Vulnerability/ Earthquake Resistance Design/ Seismic Performance Assessment
COMPUTER SCIENCE & ENGINEERING	Big Data
	Cloud & Fog Computing
	Computational Bioinformatics
	Cyber & Information Security
	Deep Learning
	Game Design and Animation
	Image Processing
	Machine Learning
	Natural Language Processing
	Optimization, Soft Computing & Swarm Intelligence
	Pattern Recognition
	Probabilistic Data Structure
	Quantum Computing
	Software Engineering
	Wireless Ad-hoc & Sensor Networks

Department/School	Specialization
ELECTRONICS & COMMUNICATION ENGINEERING	Fiber Optics Communication, Optical Sensors, Optical-Quantum Communication
	Wireless Communication, MIMO antennas, RFID antennas, Microstrip Antennas, RF Microwave
	Machine Learning, Deep Learning, Cloud Computing, Data Analytics, Soft Computing, Computer Vision
	Fractional Transforms, Image Forensics, Image, Video & Audio, Signal Processing
	Analog Mixed-Signal, Low Voltage / Low Power Analog Circuit Design , Smart Analog Circuits
	DSP, Biomedical Signal Processing, Multidimenical Systems
	Cognitive radios, Metahuraestic Optimization, RFID Tag Antenna
	VLSI Interconnects , CNT/GNR Based FET
	Wireless Sensor Networks, 5G, D-2-D Communication, M-2-M Communication, Adhoc Networks, Vehicular Adhoc Network, Wireless Network Security
	Digital VLSI Design, Light Weight Cryptography, VLSI Architecture
	MEMS Design and Fabrication of Semi Conductor Sensors
	Microwave Imaging, Microstrip Antennas for Biomedical Engineering
	Semiconductor Devices, Modeling Design of Devices & Circuits
	VLSI Systems for Signal and Image Processing algorithms, Arithmetic Components Design, Low Power VLSI Design
	Quantum Computing & Quantum Cryptography
	Networking, Software defined networks, Network function Virtualization
ELECTRICAL & INSTRUMENTATION ENGINEERING	Artificial Intelligence
	Biomedical Instrumentation
	Biomedical Signal Processing
	Biometrics
	Communication in Power System
	Control System
	Custom Power
	Electric drives
	Electronics and Instrumentation
	Embedded Systems

Department/School	Specialization
	Head up Display
	Intelligent system
	Micro-grid systems
	Optimization Algorithm
	Power and Energy Systems
	Power Converters
	Power Electronics
	Power Quality
	Power System Operation and Control
	Power System Protection
	Power Systems Optimization
	Renewable Energy Systems
	Signal and image processing
	Smart grid systems
MECHANICAL ENGINEERING	Bio fuels
	High temperature corrosion and erosion, silt erosion. thermal spray coatings, dry powder coatings, anticorrosion coatings using based on graphene.
	Fracture mechanics, FEM, XIGA, XFEM, nonlinear behavior of FGM MEMS beams, multiscale failure/damage of composite structures subjected to different environmental and loading conditions using advanced computational techniques.
	Advanced computational methods for fluids, CFD, cardiovascular fluid dynamics, bio-heat transfer, nanofluids, bulk and nanopowder technologies, modelling powder flow in additive manufacturing; energy saving bulk transport system using AI.
	Welding technologies and metallurgy, welding and characterization of welded structures, 2D-DIC for weld joint characterizations, lasers for manufacturing, hydrogen embrittlement in welded structures, additive manufacturing using welding (WAAM)
	System dynamics and control, condition monitoring, acoustics and vibrations
	Experimental mechanics, heat and mass transfer
	Solar trigeneration, supercritical CO_2 cycle, natural circulation loop, nanofluid pool boiling, thermal comfort
	Additive manufacturing/3D printing/rapid manufacturing; modelling of additive manufacturing processes, image guided bone machining using additive manufacturing

Department/School	Specialization
	Multi-axis CNC toolpath planning for machining of complex curved surfaces defined by triangulated facets and NURBS, multi-axis CNC toolpath planning for machining of composite surfaces.
	Road accident research, automobile engineering
	Residual stresses and microstructural characterization, SLM-AM and DED-AM
	Thermal design of heat exchangers for process plants, refrigeration and air conditioning, piping design and analysis for power plants, process plants and refrigeration units, machine learning in refrigeration and air conditioning
	Human ergonomics
	Advanced machining and finishing processes, numerical simulation in manufacturing processes, magnetic assisted finishing processes with low cost automation.
	Hydrogen fuel cell technology
	Robotics, exoskeletons, assistive devices, control of under actuated systems, vehicle dynamics
	Biomedical implant fabrication using rapid prototyping and tooling
	Characterization and testing of polymer matrix nanocomposites and metal matrix composites, nanoceramics
	Microwave assisted machining, surface engineering, microwave welding
	Solar thermal systems
SCHOOL OF CHEMISTRY & BIOCHEMISTRY	Environmental Chemistry
	Nanomaterial, Catalysis, Photocatalysis
	Biocatalysis & Biotransformation
	Synthetic Organic Chemistry
	Organic & Medicinal Chemistry
	Organic & Supramolecular Chemistry
	Functional nanomaterials for a sustainable environment
	Bioorganic chemistry, Computer-aided drug design, Molecular modelling and drug discovery, Biophysical chemistry
	Inorganic Chemistry, Catalysis
	Electrocatalysis, Water Splitting and Carbon dioxide reduction.
	Computational Chemistry

Department/School	Specialization
	Biocatalysis
SCHOOL OF ENERGY & ENVIRONMENT	Wastewater treatment
	Waste Water Treatment (Adsorption)
SCHOOL OF HUMANITIES & SOCIAL SCIENCES	Business Economics, E-Business, Industrial Management, Human Resource Development
	General Management, Intellectual Property Rights, Creative Industries Management, Marketing
	Entrepreneurship, Marketing Innovation
	Economics, Stock Market
	Management, Commerce, Finance & Accounts
	English Literature
SCHOOL OF MATHEMATICS	Fourier Analysis, Functional Analysis
	Theoretical Astrophysics, Astrophysics
	Operations Research, Mathematical Programming
	Fuzzy Optimization
	Mechanics, Elasticity
	Fluid Mechanics/Modeling & Simulation
	Numerical Analysis
	Fixed Point Theory, Approximation Theory, Nonlinear Analysis
	Mathematical Biology, Nonlinear Dynamics
	Numerical Partial Differential Equations
	Mathematical Modelling & Applications Of ODE
	Numerical Linear Algebra
	Theoretical Seismology
	Reliability
	Vedic Mathematics
	Number Theory and Partition Theory
SCHOOL OF PHYSICS & MATERIALS SCIENCE	Condensed Matter Physics (Experimental)
	Nuclear Physics (Theoretical)
	Materials Science
	Particle Physics
	Nanomedicine
	Nonlinear Optics, Photonics
	Thin film solar cells
	Computational Soft Condense Matter Physics
	Nanomaterials
	Multiferroics & Fuel Cell
	Condensed Matter Theory (strongly correlated system)

8.3 APPLICATION FEE : Rs. 1500/-

8.4 IMPORTANT DATES

Last date for receipt of completed application forms : June 30, 2020

OFFLINE Tests to be conducted by TIET

Departments	**Date of Offline Entrance Test**	**Time of Offline Entrance Test**
Departments		
Biotechnology	July 9, 2020	09:00 AM
Chemical Engineering	July 9, 2020	11:00 AM
Computer Science and Engineering	July 9, 2020	11:00 AM
Civil Engineering	July 9, 2020	01:00 PM
Electrical & Instrumentation Engineering	July 9, 2020	01:00 PM
Electronics & Communication Engineering	July 9, 2020	03:00 PM
Mechanical Engineering	July 10, 2020	09:00 AM
Schools		
School of Physics & Materials Science	July 10, 2020	11:00 AM
School of Humanities & Social Sciences	July 10, 2020	09:00 AM
School of Mathematics	July 10, 2020	01:00 PM
School of Energy and Environment	July 10, 2020	01:00 PM
School of Chemistry & Biochemistry	July 10, 2020	03:00 PM

Venue of Offline Entrance Test : Patiala

Display of Result of Entrance Test : July 15, 2020

Date of interview for Ph.D. : July 22-24, 2020

8.5 DURATION

The student shall submit his/her thesis to the Registrar within five years but not earlier than 2.5 years in case of regular and 3.5 years in case of part time student from the date of his/her admission.

8.6 TEACHING ASSOCIATESHIP

Eligibility: Only those candidates will be considered for Teaching Associateship who are GATE/GPAT/NET (UGC/CSIR) qualified. A candidate should have minimum CGPA of 6.0 (10-point Scale) or 60% marks in the qualifying exam. However, depending upon the teaching load requirement of a department/school, if GATE/GPAT/NET (UGC/CSIR) qualified candidates are not available, PhD candidates who are not GATE/GPAT/NET (UGC/CSIR) qualified may also be considered. Such candidates

should have minimum CGPA of 7.0 (10-point Scale) or 70% marks in the qualifying exam to be eligible for Teaching Associateship. The candidate must have completed his/her course work (including Seminar).

Number of Associateship: Teaching Associateship are allocated to each Department/School depending upon their teaching load requirement. 80 Teaching Associateships shall be given every year to regular Ph.D. students. At any stage, maximum 240 Teaching Associateships shall be given to all the Ph.D. students on roll.

Duration of Associateship: Teaching Associateships shall be awarded for a maximum period of 3-years subject to review of performance at the end of every year. However, if a student submits his/her thesis in less than three years, then Teaching Associateship will be given to him/her till the end of ongoing semester during which he/she submitted the thesis.

Emoluments of Associateship: Emoluments for Teaching Associateship will be ₹25,000/- for GATE/GPAT/NET (UGC/CSIR) qualified candidates. Emoluments for Teaching Associateship will be ₹18,000/- for candidates who are not GATE/GPAT/NET (UGC/CSIR) qualified. **In addition to this, NET (UGC/CSIR) or GATE/GPAT (GATE/GPAT score should be valid at the time of admission) qualified candidates will also be given half tuition fee waiver."**

General Conditions:

- A scholar who has been selected for the award will be given 8-12 hours of teaching load per week.
- A scholar who has been selected for associateship shall not be eligible for any other fellowship from the Institute or from any other source.
- A scholar who has been selected for associateship shall be liable to pay tuition fee and other dues as prescribed by the Institute from time to time.

8.7 IMPORTANT NOTE

1 For all Ph.D. programs offered by a particular department/school, single application form is required to be filled. However, if candidate want to apply for Ph.D. program of other department/school also, then he/she is required to select an additional department/school along with requisite application fee.

2 **If Application Fee is paid Online**: The candidates are not required to send the printout of application form but they must produce it at the time of interview.

If Application Fee is paid through DD: Please send one of the printouts by attaching DD of required amount as mentioned in filled online Application Form/Prospectus (in favour of **Thapar Institute of Engineering & Technology** and payable at Patiala) to "**In-charge Admission Cell' Thapar Institute of Engineering & Technology, Patiala (Punjab)-147 004**.

3 The policy of UGC guidelines regarding reservation of seats for SC/ST and PH candidates shall be followed.

4 No separate intimation will be sent regarding conduct of Entrance Exam, Interview and start of session.

5 In case of a tie among candidates securing equal marks in the merit list, the same will be broken in accordance with the following criteria:

a. Candidate senior in age shall rank higher in order of merit.
b. In the case of a tie in age also, a candidate getting higher percentage of marks in the qualifying examination shall be ranked higher in order of merit.

c. In the case of a tie in percentage of marks in the qualifying examination also, a candidate securing higher percentage of marks in matriculation/secondary or equivalent examination shall rank higher in order of merit.

6 Candidates appearing in the final exam of the qualifying degree are also eligible to apply. Such candidates have to furnish following undertaking at the time of counselling.

"I am applying on my own risk and responsibility as my final result of the Qualifying Exam has not been declared.

I do hereby declare that I do not have any backlog paper in any of the previous semesters (Years) of study of the qualifying exam and also, I do not expect any backlog in my final exam.

I assure you that I will produce the proof of passing of my Qualifying Examination with the minimum percentage of marks required on or before December 31, 2020, failing which my admission shall stand cancelled and I shall not claim any right on any count whatsoever."

8.8 INSTRUCTIONS FOR OFFLINE ENTRANCE TEST

1 Entrance Test for Ph.D. programme shall be conducted OFFLINE.

2 The Admit Cards for offline entrance test shall be sent to registered email IDs (as mentioned in online application form) of the candidates provided their DD along with print out of application form reaches Thapar Institute of Engineering & Technology within the stipulated time, in case application fee paid through DD.

Note: The Admit Card shall be issued provisionally to the candidate subject to his/her satisfying the eligibility condition.

3 The candidate shall take out two printouts of 'Admit Card", paste latest photograph on each and then come to the Entrance Test Centre. Along with admit cards, the candidate will also carry any one of the identity proof (Original) with him/her like Aadhar Card/Passport/Voter Identity Card/ PAN Card/ Driving License. One copy of the admit card shall be retained by the entrance test centre. The candidate shall keep the other copy (duly acknowledged by the examiner at test centre) to be shown at the time of document checking during counselling.

4 Electronic gadgets such as Calculators, Mobile Phones, Pagers, etc. are not permitted in the Examination Centre.

5 The Entrance Test shall contain 80 objective type questions. Duration of the Entrance Test will be 90 minutes.

6 The total marks of the test will be 80.

7 The test will be taken in the concerned subject area.

8 Cut off marks in the entrance test will be 50% (45% for SC/ST) of the total marks.

9 There will be no negative marking in the test.

Ph.D. Entrance Examination Syllabus

DEPARTMENT OF BIOTECHNOLOGY

Mental ability and aptitude, research aptitude, biostatistics and biomathematics: Algebra, trigonometry, determinants and matrices, coordinate geometry, differential and integral calculus, Measures of central tendencies and dispersion, probability and distributions, hypothesis testing, Z, t, two sample test, ANOVA, Tukey test, non-parametric tests, chi-square test, correlation and regression

Microbiology: Classification of microorganisms, microbial growth and nutrition, microbial physiology, preservation and control of microorganisms, microbial diseases, microbial genetics

Genetics: Mendelian genetics, patterns of inheritance – incomplete dominance, multiple alleles, co-dominance, lethal genes, polygenic inheritance, sex linked inheritance, cell division, chromosomal structure and genetic material

Biochemistry: Biomolecules- structure and function, intra- and intermolecular forces, bioenergetics, biochemical equilibria, signal transduction and regulation, metabolism of carbohydrates, lipids, proteins and nucleic acids and biochemical techniques.

Molecular biology and genetic engineering: DNA replication in prokaryotes and eukaryotes, DNA damage and repair, recombination, Transcription and translation in prokaryotes and eukaryotes, RNA processing, genetic code, post-translational modifications, transfer of genetic material in microorganism, gene silencing, oncogenes, genetic disorders, apoptosis, DNA modifying enzymes, molecular cloning, cloning & expression vectors, genomic & cDNA libraries, recombinant gene expression & its applications and molecular techniques.

Plant biotechnology: Plant tissue culture, micropropagation, production of haploid plants, embryo culture, soma clonal variations, germplasm conservation, manipulatin of phenotypic traits by recombinant DNA technology, plant vectors and methods of DNA transfer, generation of transgenic plants and their applications

Animal biotechnology and Immunology: Mammalian cell culture, culturing types, types of media, viability assay, contamination and cryopreservation, transgenic animals and animal cloning, gene therapy, stem cells and their application, Innate and adaptive immunity, Cells of immune systems, humoral and cell mediated immunity, compliment systems, cytokines, MHC, antigen & antibody and their interactions, immunological techniques, autoimmunity, hypersensitivity and

immunodeficiency, immune response to infectious diseases, cancer and transplantation and vaccines.

Bioinformatics: Biological databases, biological sequence formats, pairwise sequence alignment – methods and algorithms, FASTA, BLAST, multiple sequence alignment and phylogenetics, structural bioinformatics, Ramachandran plot, protein secondary and tertiary structure prediction methods and algorithms and homology modeling

Environmental Biotechnology: Ecology, environmental pollution and control, bioprocesses in controlling pollution, biomonitoring and biosensors.

Enzymology and bioprocess technology: Enzyme classification and nomenclature, enzyme kinetics & mechanism, activators and inhibitors, regulation of enzyme activities, sterilization concepts in fermentation, cell growth and kinetics, bioreactor studies, aeration & agitation and downstream processing.

CHEMICAL ENGINEERING DEPARTMENT

First and second laws of thermodynamics and their applications, phase equilibria, chemical reaction equilibria; flow through pipes, boundary layers, two phase flow; fluidization and its applications; heat transfer coefficients and equipment; diffusion, absorption, adsorption, distillation, extraction, transport analogies; kinetics of homogeneous reactions, interpretation of kinetic data, residence time distribution, kinetics and reactor design for heterogeneous reactions, water and air pollutants and their treatments, enzyme kinetics, bioreactor analysis; modeling and simulation.

CIVIL ENGINEERING DEPARTMENT

STRUCTURAL ENGINEERING

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

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

Matrix methods of structural analysis, Plastic Analysis of Structures and Introduction to Finite Element Method of Analysis.

Introduction to Dynamic Analysis of Structures: Understand basic concepts related to dynamic analysis of structures Perform analysis of SDOF and MDOF systems.

Concrete Structures: Concrete Technology- properties of concrete, basics of mix design. Concrete design- basic working stress and limit state design concepts, analysis of ultimate load capacity and design of members subjected to flexure,

shear, compression and torsion by limit state methods. Design and reinforcement detailing of building frames. · Design and detail RC retaining structures ·Basic elements of prestressed concrete, analysis of beam sections at transfer and service loads.

Understand the use of supplementary cementing materials as cement replacement in concrete. To design high strength and high performance concretes

Steel Structures: Analysis and design of tension and compression members, beams and beam columns, column bases. Connections- simple and eccentric, beam–column connections, plate girders and trusses. Plastic analysis of beams and frames. Carry out plastic design of structural elements · Analyse and design industrial buildings and storage structures · Analyse and design structures using light gauge steel and aluminium ·

GEOTECHNICAL ENGINEERING

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

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

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Properties of fluids, principle of conservation of mass, momentum, energy and corresponding equations, potential flow, applications of momentum and Bernoulli's equation, laminar and turbulent flow, flow in pipes, pipe networks.

Concept of boundary layer and its growth: Uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies, flow measurements in channels, tanks and pipes. Dimensional analysis and hydraulic modelling. Kinematics of flow, velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, unit hydrographs, flood estimation, reservoir capacity, reservoir and channel routing. Well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration. Crop water requirements. Design of: lined and unlined canals, waterways, head works, gravity dams and spillways. Design of weirs on permeable foundation. Types of irrigation system, irrigation methods. Water logging and drainage, sodic soils.

ENVIRONMENTAL ENGINEERING

Water requirements: 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, sludge disposal, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment Unit operations and unit processes of domestic wastewater, 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.

TRANSPORTATION ENGINEERING

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

Traffic Engineering: Traffic characteristics, theory of traffic flow, intersection design, traffic signs and signal design, highway capacity.

SURVEYING

Importance of surveying, principles and classifications, mapping concepts, coordinate system, map projections, measurements of distance and directions, levelling, theodolite traversing, plane table surveying, errors and adjustments, curves.

COMPUTER SCIENCE AND ENGINEERING DEPARTMENT

Section A:

Mathematical and General Aptitude: Discrete structures (sets, graphs, elementary counting and probability), elementary calculus, linear algebra, Calculus, Differential equations, Complex variables, Numerical Methods, Transform, Quantitative and Analytical Reasoning.

Section B:

Programming Aptitude: Ability to write programs to solve simple problems. Use of elementary data structures such as arrays, lists, stacks, queues, trees. Familiarity with recursion. Ability to reason about programs, loop invariants and assertions.

Section C:

Computer Science and Engineering: Algorithm Design and Analysis, Theory of Computation, Database Management Systems, Operating Systems, Computer

Networks, Machine Learning, Computer Graphics, Compiler Construction, Software Engineering, Computer System Architecture.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

Network Theorems: superposition, Thevenin and Norton's Maximum Power Transfer, Fourier series. time domain analysis of simple RLC circuits. Laplace and Z transforms; frequency domain analysis of RLC circuits. Two port network parameters.

Analog Circuits: Characteristics and equivalent circuits (large and small signal) of diodes, BJTs, JFETs and MOSFETs Simple diode circuits: clipping, clamping, rectifier Biasing and bias stability of transistor and FET amplifiers.

Amplifiers: Single and multistage, Differential, Operational; feedback and power. Analysis of amplifiers; Simple op-amp circuits. Filters, oscillators.

Digital Circuits: Boolean algebra; minimization of Boolean functions; logic gates, Digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits; arithmetic circuits, Code converters, Multiplexers and decoders. Sequential circuits; Latches and flip-flops, Counters and shift registers.

Communication System: Analog and Digital Communication systems. AM, FM, PM modulation and demodulation. Fourier analysis of signals amplitude, Phase and power spectrum, Autocorrelation and cross-correlation and their Fourier transform. Super-heterodyne receivers. Sampling theorem. Pulse code modulation (PCM), delta modulation (DM). Digital modulation techniques (ASK, PSK, FSK, QAM). Matched filter and probability of error.

Electromagnetism: Gradient, Divergence and curl; Gauss' and Strokes' theorems, Maxwell's equations: differential and integral forms. Wave equation. Pointing vector. Transmission lines: Characteristics impedance;

Waveguides: Modes in rectangular waveguides; Boundary conditions; Cut-Off frequencies; Dispersion relations.

Antennas: Dipole antennas; Antenna arrays; Radiation pattern; Reciprocity theorem; Antenna gain.

Microprocessors: Evolution, microcomputer architecture; Intel 8085: architecture, addressing mode, Instruction set, Programming technique, Interrupt Structure; Intel 8086: architecture, concept of segmented memory, Addressing modes, Instruction set, Programming techniques, Interrupt Structure;

ELECTRICAL ENGINEERING

Electric Circuits and Fields: Network graph, KCL, KVL, node and mesh analysis, transient response of dc and ac networks; sinusoidal steady-state analysis, resonance, basic filter concepts; ideal current and voltage sources, Thevenin's, Norton's and Superposition and Maximum Power Transfer theorems, two-port networks, three phase circuits; Gauss Theorem, electric field and potential due to point, line, plane and spherical charge distributions; Ampere's and Biot-Savart's laws; inductance; dielectrics; capacitance.

Signals and Systems: Representation of continuous and discrete-time signals; shifting and scaling operations; linear, time-invariant and causal systems; Fourier series representation of continuous periodic signals; sampling theorem; Fourier, Laplace and Z transforms.
Electrical Machines: Single phase transformer – equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers – connections, parallel operation; auto-transformer; energy conversion principles; DC machines – types, windings, generator characteristics, armature reaction and commutation, starting and speed control of motors; three phase induction motors – principles, types, performance characteristics, starting and speed control; single phase induction motors; synchronous machines – performance, regulation and parallel operation of generators, motor starting, characteristics and applications; servo and stepper motors.

Power Systems: Basic power generation concepts; transmission line models and performance; cable performance, insulation; corona and radio interference; distribution systems; per-unit quantities; bus impedance and admittance matrices; load flow; voltage control; power factor correction; economic operation; symmetrical components; fault analysis; principles of over-current, differential and distance protection; solid state relays and digital protection; circuit breakers; system stability concepts, swing curves and equal area criterion; HVDC transmission and FACTS concepts.

Control Systems: Principles of feedback; transfer function; block diagrams; steady-state errors; Routh and Nyquist techniques; Bode plots; root loci; lag, lead and lead-lag compensation; state space model; state transition matrix, controllability and observability.

Power Electronics and Drives: Semiconductor power diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs – static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters – fully controlled and half controlled; principles of choppers and inverters; basis concepts of adjustable speed dc and ac drives.

INSTRUMENTATION & CONTROL ENGINEERING

Instrumentation Engineering Basics of Circuits and Measurement Systems: Kirchoff's laws, mesh and nodal Analysis. Circuit theorems. One-port and two-port Network Functions. Static and dynamic characteristics of Measurement Systems. Error and uncertainty analysis. Statistical analysis of data and curve fitting.

Transducers, Mechanical Measurement and Industrial Instrumentation: Resistive, Capacitive, Inductive and piezoelectric transducers and their signal conditioning. Measurement of displacement, velocity and acceleration (translational and rotational), force, torque, vibration and shock. Measurement of pressure, flow, temperature and liquid level. Measurement of pH, conductivity, viscosity and humidity.

Analog Electronics: Characteristics of diode, BJT, JFET and MOSFET. Diode circuits. Transistors at low and high frequencies, Amplifiers, single and multi-stage. Feedback amplifiers. Operational amplifiers, characteristics and circuit configurations. Instrumentation amplifier. Precision rectifier. V-to-I and I-to-V converter. Op-Amp based active filters. Oscillators and signal generators.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions. IC families, TTL, MOS and CMOS. Arithmetic circuits. Comparators, Schmitt trigger, timers and mono-stable multi-vibrator. Sequential circuits, flip-flops, counters, shift registers. Multiplexer, S/H circuit. Analog-to-Digital and Digital-to-Analog converters. Basics of number system. Microprocessor applications, memory and input-output interfacing. Microcontrollers.

Signals, Systems and Communications: Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first- and second order systems. Convolution, correlation and characteristics of linear time invariant systems. Discrete time system, impulse and frequency response. Pulse transfer function. IIR and FIR filters. Amplitude and frequency modulation and demodulation. Sampling theorem, pulse code modulation. Frequency and time division multiplexing. Amplitude shift keying, frequency shift keying and pulse shift keying for digital modulation.

Electrical and Electronic Measurements: Bridges and potentiometers, measurement of R, L and C. Measurements of voltage, current, power, power factor and energy. AC & DC current probes. Extension of instrument ranges. Q-meter and waveform analyzer. Digital voltmeter and multi-meter. Time, phase and frequency measurements. Cathode ray oscilloscope. Serial and parallel communication. Shielding and grounding. 50

Control Systems and Process Control: Feedback principles. Signal flow graphs. Transient Response, steady-state-errors. Routh and Nyquist criteria. Bode plot, root loci. Time delay systems. Phase and gain margin. State space representation of systems. Mechanical, hydraulic and pneumatic system components. Synchro pair, servo and step motors. On-off, cascade, P, P-I, P-I-D, feed forward and derivative controller, Fuzzy controllers.

Analytical, Optical and Biomedical Instrumentation: Mass spectrometry. UV, visible and IR spectrometry. X-ray and nuclear radiation measurements. Optical sources and detectors, LED, laser, Photo-diode, photo-resistor and their characteristics. Interferometers, applications in metrology. Basics of fibre optics. Biomedical instruments, EEG, ECG and EMG. Clinical measurements. Ultrasonic transducers and Ultrasonography. Principles of Computer Assisted Tomography.

MECHANICAL ENGINEERING DEPARTMENT

Mechanical Design

Engineering Mechanics: Resultant of forces, free-body diagrams and equilibrium of particle and rigid bodies, trusses and frames, friction, centroid and second moment of area.

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

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears.

Theory of Machines: Plane mechanisms, dynamic analysis of linkages; cams; gears and gear trains; flywheels; balancing of reciprocating and rotating masses, velocity and acceleration diagrams.

Vibrations: Free and forced vibration of single degree of freedom systems, effect of viscous and Coulomb damping; vibration isolation; resonance, natural frequency and mode shapes.

Manufacturing Processes

Metal Casting: Casting processes – types and applications; patterns – types and materials; allowances; moulds and cores; permanent-mold casting, die casting, cold-chamber and hot-chamber die casting, centrifugal casting.

Metal Forming: Hot and cold working – forging, rolling, extrusion, wire and tube drawing; sheet metal working processes such as blanking, piercing, bending, deep drawing, coining and embossing.

Metal Joining Processes: Welding processes – manual metal arc, MIG, TIG, plasma arc, submerged arc, thermit, resistance, friction, other joining processes – soldering and brazing.

Basic Machining and Machine Tool Operations: Machine tools; machining processes-turning, drilling, boring, milling, shaping, planing, grinding, geometry of cutting tools, chip formation, tool materials, cutting fluids and their functions; principles of non-traditional machining processes – USM, AJM, WJM, EDM, LBM, CHM, ECM.

Thermal and Fluid Engineering

Thermodynamics: Thermodynamic laws, properties, path and point functions, energy equation, heat engine and refrigeration cycles, entropy change due to heating and cooling, entropy generation, thermodynamic property diagrams, different cycles with advanced arrangements: Rankine, gas turbine, Otto, Diesel, vapour compression, vapour absorption, combined cycles, psychometric properties

Fluid Mechanics and Fluid Machinery: Types of fluids and flows, viscosity, pressure distribution in static fluid systems, velocity and shear stress distribution for fluids in motion, laminar and turbulent flow, dimensionless numbers, pressure drop in laminar, turbulent flows, series and parallel pipe flow, boundary layer formation, drag and lift forces, compressible flow, flow through nozzles and diffusers, velocity diagrams and performance of turbines, pumps and compressors and characteristic curves

I.C. Engines: Different types of efficiencies, combustion stages, knocking, engine testing and performance.

Heat Transfer: Fourier law of heat conduction, thermal resistance in conduction, convection and radiation in series and parallel, critical radius of insulation, empirical relations used in forced and natural convections over flat surfaces, black body radiation.

Interdisciplinary

Broad understanding of basic sciences and mathematics (including general principles of physics, chemistry, mathematics, basic electrical, basic electronics,

measurement techniques, basic statistics), broad idea of environmental pollution, conventional and non-conventional energy sources.

Scholastic Aptitude

SCHOOL OF CHEMISTRY AND BIO-CHEMISTRY

Chemistry Syllabus for Ph.D. Entrance Test

Physical Chemistry:

1. Basic principles and applications of quantum mechanics – hydrogen atom, angular momentum.
2. Variational and perturbational methods.
3. Basics of atomic structure, electronic configuration, shapes of orbitals, hydrogen atom spectra.
4. Theoretical treatment of atomic structures and chemical bonding.
5. Chemical applications of group theory.
6. Basic principles and application of spectroscopy – rotational, vibrational, electronic, Raman, ESR, NMR.
7. Chemical thermodynamics.
8. Phase equilibria.
9. Statistical thermodynamics.
10. Chemical equilibria.
11. Electrochemistry – Nernst equation, electrode kinetics, electrical double layer, Debye-Hückel theory.
12. Chemical kinetics – empirical rate laws, Arrhenius equation, theories of reaction rates, determination of reaction mechanisms, experimental techniques for fast reactions.
13. Concepts of catalysis.
14. Polymer chemistry. Molecular weights and their determinations. Kinetics of chainpolymerization.
15. Solids - structural classification of binary and ternary compounds, diffraction techniques, bonding, thermal, electrical and magnetic properties
16. Collids and surface phenomena.
17. Data analysis.

Inorganic Chemistry

1. Chemical periodicity

2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules.

3. Concepts of acids and bases.

4. Chemistry of the main group elements and their compounds. Allotropy, synthesis, bonding and structure.
5. Chemistry of transition elements and coordination compounds – bonding theories, spectral and magnetic properties, reaction mechanisms.

6. Inner transition elements – spectral and magnetic properties, analytical applications.

7. Organometallic compounds - synthesis, bonding and structure, and reactivity. Organometallics in homogenous catalysis.

8. Cages and metal clusters.

9. Analytical chemistry- separation techniques. Spectroscopic electro- and thermoanalytical methods.

10. Bioinorganic chemistry – photosystems, porphyrines, metalloenzymes, oxygen transport, electron- transfer reactions, nitrogen fixation.

11. Physical characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-, NQR, MS, electron spectroscopy and microscopic techniques.

12. Nuclear chemistry – nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

Organic Chemistry

1. IUPAC nomenclature of organic compounds.

2. Principles of stereochemistry, conformational analysis, isomerism and chirality.

3. Reactive intermediates and organic reaction mechanisms.

4. Concepts of aromaticity.

5. Pericyclic reactions.

6. Named reactions.

7. Transformations and rearrangements.

8. Principles and applications of organic photochemistry. Free radical reactions.

9. Reactions involving nucleophotic carbon intermediates.

10. Oxidation and reduction of functional groups.

11. Common reagents (organic, inorganic and organometallic) in organic synthesis.

12. Chemistry of natural products such as steroids, alkaloids, terpenes, peptides, carbohydrates, nucleic acids and lipids.

13. Selective organic transformations – chemoselectivity, regioselectivity, stereoselectivity, enantioselectivity. Protecting groups.

14. Chemistry of aromatic and aliphatic heterocyclic compounds.

15. Physical characterisation of organic compounds by IR, UV-, MS, and NMR.

Interdisciplinary Topics

1. Chemistry in nanoscience and technology.

2. Catalysis and green chemistry.

3. Medicinal chemistry

4. Supramolecular chemistry.

5. Environmental chemistry.

Biochemistry Syllabus for Ph.D. Entrance Test

Molecules and their interaction relevant to biology:

1. Structure of atoms, molecules and chemical bonds.

2. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

3. Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).

4. Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

5. Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

6. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes

7. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).

8. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).

Cellular organization

1. Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

2. Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

3. Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons.

4. Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.

5. Growth yield and characteristics, strategies of cell division, stress response.

Fundamental processes

1. DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).

2. RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).

3. Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).

4. Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

Metabolism of carbohydrates, lipids, amino acids

1. Chlorophyll structure, Photosynthesis, Photophosphorylation, dark reaction, light reaction, CO2 fixation.

2. Glycolysis, TCA cycle, Pentose Phosphate pathway, electron transport chain, oxidative phosphorylation, FoF1 ATPase, gluconeogenesis, glycogenesis, glycogenolysis, anaerobic glycolysis. diseases associated with it.

3. Fatty acid biosynthesis, α-oxidation, β-oxidation, ω-oxidation, energy yield, associated diseases.

4. Amino acid biosynthesis and associated diseases

Immunology and cell signaling

1. Host parasite interaction recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, pathogen-induced diseases in animals.

2. Cell surface receptor, signaling through G-protein coupled receptors, second messengers, regulation of signaling pathways, Na+/K+ ion channel signaling, p53, NFkB, p21, p16, AKT related signaling pathways.

3. Gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

4. Oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

5. Innate and adaptive immune system. Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, HIV and acquired immuno-deficiencies, vaccines.

Applied biology:

1. Microbial fermentation and production of small and macro molecules.

2. Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for plants and animals.

3. Transgenic animals and plants, molecular approaches to diagnosis and strain identification.

4. Genomics and its application to health and agriculture, including gene therapy.

5. Bioresource and uses of biodiversity.

Methods in biology

1. Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods. Analysis of RNA, DNA and proteins by one and two-dimensional gel electrophoresis, Isoelectric focusing gels. Molecular cloning of DNA. Plasmid, phagemid, cosmid, BAC and YAC vectors. Expression of recombinant proteins using bacterial and animal vectors. Isolation of specific nucleic acid sequences. Protein sequencing methods, detection of post translation modification of proteins. DNA sequencing methods, strategies for genome sequencing. Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques Isolation, separation and analysis of carbohydrate and lipid molecules RFLP, AFLP and SNP techniques

2. Antibody generation, detection of molecules using ELISA, RIA, western blot, immuno-precipitation, flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

3. Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

4. Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, working principles of SEM, TEM and AFM.

SCHOOL OF ENERGY AND ENVIRONMENT

Syllabus for Ph.D. Environment Science and Technology

Environmental microbiology; Ecology; Environment chemistry; Environment pollution; Environment technologies; Fluid mechanics; Environment quality monitoring; Water and wastewater treatment technology (Physico-chemical and Biological); Air Quality; Air pollution control technology; Solids and hazardous waste management. Energy resources; Conventional energy technology; Fuels and combustion; Renewable energy Technologies.

SCHOOL OF HUMANITIES & SOCIAL SCIENCES

Syllabus for Ph.D. (Economics)

Research Methodology, Micro Economics, Macro Economics, Growth & Development, Money Banking & Financial Markets, Indian Economy, International Business Political Economy, Statistical Methods, Global Business Environment, Corporate Governance & Industrial Policy.

Syllabus for Ph.D. (Commerce/ Financial Management)

Research Methodology, Principles of Management, Financial Management, Securities & Portfolio Management, Financial Derivatives, International Financial Management, Financial Accounting, Direct and Indirect Taxes, Risk Management, Behavioural Finance, Strategic Financial Management, Financial Institutions & Financial Services.

Syllabus for Ph.D. (Commerce/ Marketing Management)

Research Methodology, Principles of Management, Marketing Management, Global Marketing and E-Business, Product and Brand Management, Service Marketing & CRM, Market Research, Consumer Behavior, Agricultural and Rural Marketing, Advertising Management & Retailing.

Syllabus for Ph.D. (Commerce/ Human Resource Management)

Research Methodology, Principles of Management, Human Resource Management (HRM), Forces and Influences, Recruitment and Selection, Performance Appraisal System, Development of Personnel, Career Planning and Development, Compensation and Benefits–Job evaluation techniques, Industrial Democracy and Employee Participation–Need for industrial democracy, Future of Human Resource Management.

Syllabus for Ph.D. (Communication Skills)

Components of communication /Barriers in communication, Kinds of communication, Communication at Work Place (Office), Importance and benefits of effective communication, Components / Process of communication, The 7 C's of Effective communication, Writing Skills, Planning and Writing Documents, Business letters, Report writing, Kinds of Reports (Long & Short Reports), Grammar, Style, Punctuation, Practice in Actual Communication.

Syllabus for Ph.D. (English Literature)

Major Genres and their History, Important Literary terms, History of English Literature from Chaucer to the late 20th century including literary movements and well known literary works. Important works and literary figures of late 19th century and early 20th century pertaining to European Literature and American – Canadian Literature. Postcolonial and Postmodern writing, Indian Writing in English, Literary Criticism and Literary Theory.

SCHOOL OF MATHEMATICS

Note: Candidates seeking admission in mathematics are required to attempt any five sections only.

Section – I

Sequences and series of functions, point wise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-Stieltjes integration, uniform convergence and differentiation, Weierstrass approximation theorem.

Open and closed Sets, Interior, Closure and limit points of a set, Subspaces, Continuous functions on metric spaces, Convergence in a metric space, complete metric spaces, Compact metric spaces, Compactness and uniform continuity.

Definition, Existence and properties of Riemann integral of a bounded function, Darboux theorem, Condition of integrability, Riemann integrability for continuous functions, bounded functions, monotonic function and functions with finite or infinite number of discontinuities (without proof). The integral as the limit of the sums, Properties of Riemann integral, Fundamental theorem of calculus, First Mean value theorems, Change of variables, second mean value theorem, Generalized mean value Theorems.

Section – II

Algebra of complex numbers, the complex plane, polynomials, power of series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy- Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle.

Measurable sets. Measurable functions. Lebesgue measurability. Non-measurable sets. Integration of Non-negative functions. Riemann and Lebesgue Integrals.

Section – III

Groups, Subgroups, Normalizer, Centralizer, Normal subgroups, Quotient groups, Homomorphism, Automorphisms of groups and structure of cyclic groups, Permutation groups, Cayley's theorem, Conjugate elements, Class equation, Structure theory of groups, Cauchy theorem, Sylow theory and its applications. Special kinds of rings, Subrings and ideals, Algebra of ideals, Homomorphism, Quotient rings, Prime and maximal ideals, Quotient rings, Polynomial rings, Integral domain, Factorization theory in integral domains, Unique factorization domain, Principal ideal domain, Euclidean domain.

Section – IV

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, Number Theory, arithmetic functions, properties of congruence.

Section - V

Existence and Uniqueness of solutions of initial value problems for first-order ordinary differential equations, singular solutions of first-order ODEs. Applications of differential equations to vibrations of mass on a spring, Resonance phenomenon. General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm - Liouville boundary value problem, Green's function.

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.

Section – VI

Numerical solutions of algebraic equations, Method of iterations and Newton-Raphson method, Order 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.

Section – VII

Convex sets, Basic feasible solutions of LPP, Simplex method (including Big M and two phase methods), degenerate solutions, alternate optimal solutions and unboundedness in LPP, Duality in LPP, Integer programming problem and sensitivity analysis in LPP. Transportation problem, Assignment problem and travelling salesman problem. Nonlinear programming: Convex functions, Concave functions and their properties, Necessary and sufficient optimality criteria of first and second order for

unconstrained optimization problems, Kuhn-Tucker (K.T.) conditions for constrained programming problem with inequality constraints. Lagrange's multiplier method, Wolfe's and Beale's method for quadratic programming problem.

Section – VIII

Tangential and normal accelerations, Simple harmonic motion, projectile motion, Central forces, Apses and apsidal distances, Kepler's laws of planetary motion, Simple pendulum, Motion in a resisting medium, Euler's dynamical equations for the motion of a rigid body about an axis. Constrained motion, D'Alemberts principle, Variational Principle, Lagrange's equations of motion, Generalised coordinates, cyclic coordinates, Hamilton's principles, Principles of least action, Hamilton's equation of motion.

SCHOOL OF PHYSICS AND MATERIALS SCIENCE

Section A (For students having Master's Degree in Science)

Mathematical Methods of Physics

Vector algebra and vector calculus, Eigenvalues and eigenvectors, Differential equations, Fourier series, Laplace transforms, Elementary probability theory, Binomial, Poisson and normal distribution.

Classical Mechanics

Newton's laws, Two body Collisions, Rigid body dynamics, Lagrangian and Hamiltonian formalism and equations of motion, Special theory of relativity, Lorentz transformations, Relativistic kinematics and mass energy equivalence.

Electromagnetic Theory

Gauss's law and its and its applications, Biot-Savart law, Ampere's theorem, Electromagnetic induction, Maxwell's equations, Electromagnetic waves in free space, Dielectrics and conductors.

Quantum Mechanics

Wave-particle duality, Schrödinger equation, Particle in a box, Tunneling through a barrier, Heisenberg uncertainty principle, Angular momentum algebra, Addition of angular momenta, Pauli exclusion principle.

Statistical Physics

Micro-canonical, canonical and grand-canonical ensembles and partition functions, Classical and quantum statistics, Blackbody radiation and Planck's distribution law.

Electronics

Semiconductor devices (diodes, junctions, transistors, field effect devices), Solar cells, Photo-detectors, LEDs, Operational amplifiers, Digital techniques and application, A/D and D/A converters.

Condensed Matter Physics

Bravais lattices, Reciprocal lattice, Diffraction, Bonding of solids, Electrical and thermal conductivity, Hall effect, Band theory of solids: metals, insulators and semiconductors, Superconductivity: type-I and type-II superconductors, Defects and dislocations.

Nuclear and Particle Physics

Basic nuclear properties: size, shape and charge distribution, spin and parity, Binding energy, Semi-empirical mass formula, Liquid drop model, Shell Model, Nature of the nuclear force, Form of nucleon-nucleon potential, Ideas of alpha, beta and gamma decays and their selection rules, fusion and fission, Nuclear reactions, Classification of fundamental forces, Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness), Quark model, Baryons and Mesons.

Section B (For students having Master's Degree in Engineering)

Fundamentals of Materials Science:

Crystalline and non-crystalline materials; Crystal structure, Miller Indices, crystal planes and directions; Chemical bonds; Crystal imperfections, defect structure, vacancies and substitutional impurities, dislocations, twin, tilt and grain boundaries; Diffusion, laws of diffusion and their kinetics; Phase rule and Phase diagrams**, l**aws of thermodynamics, stability and meta-stability, solid solutions, Hume-Rothery rules, Unary and binary systems, Isomorphous and eutectic systems, ternary system, cooling curve, zone refining.

Materials Processing:

Solidification from liquid and vapor Phase: Nucleation and growth, homogeneous and heterogeneous nucleation, development of micro structure, super cooling, casting techniques; Forming processes: fundamentals of metal forming, hot working process; rolling, forging, extrusion, piercing, cold working; bending, shearing, squizing; Metals Processing: welding, brazing, and soldering; Ceramic Processing: Synthesis of ceramic powders, powder compaction, Extrusion, Injection moldings, Slip casting, Solid state and liquid phase sintering.

Solid State and Vapor Phase Processing: Solid state reactions: Calcinations and sintering, Kinematics of solid state reaction, Solid state and liquid phase sintering, Vapor-phase reactions; Sol-Gel Processing, Hydrolysis, Condensation and gelation, Aging, Drying of gels; Hypercritical drying.

Properties of Materials:

Mechanical Properties of Materials: Elastic, Anelastic and Viscoelastic behavior, Plastic behaviour of solids, Critical shear stress, Twinning and slipping phenomenon, Creep; Strengthening Mechanisms: Cold working and annealing, Grain boundary hardening, Solute hardening, Precipitation hardening.

Conducting and Resistor Materials: Conducting and resister materials, Coefficient of thermal expansion, Matthiessen and Nordheim rules for alloys and their engineering application.

Semiconductors: Semiconducting materials, Element and compound semiconductors their properties and applications.

Magnetic Materials: Magnetic materials, Soft and hard magnetic materials their properties and applications.

Dielectric Materials: Dielectric materials, Polarization, Dielectric loss and dielectric breakdown, Ferro, Piezo-and Pyroelectric materials, their properties and applications.

Characterization of Materials:

Optical Microscopy, Stereomicroscopy; TEM; SEM; XRD; Thermogravimetric analysis; Differential thermal analysis; Differential Scanning calorimetry; Thermo-mechanical analysis and dilatometry; Tensile testing, Hardness testing, Impact testing, Fatigue testing, Creep testing, Torsion testing; Non-destructive Testing: Magnetic particle testing, Eddy current testing, Radiography, Ultrasonic testing, Thermography, In-situ metallography.

Advanced Materials:

Nanomaterials: Quantum Size Effect, Idea of quantum well, dot and wire, Fullerenes, Nanotubes and nanostructured carbon coatings; Ferrites and piezoelectric materials and their applications; Electro-ceramics: Electronic and ionic conductivity, Ceramic semiconductors, Actuators, Capacitors and fibers.