1. Ph.D. PROGRAMME

Mode of Program: Regular/Part-time

1.1 ELIGIBILITY

i. A candidate seeking admission to the degree of Doctor of Philosophy must have obtained M.E./M.Tech./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% (55% in case of SC/ST/Differently-Abled candidates) marks in aggregate where marks are awarded **OR** have qualified the GATE / CSIR-UGC NET or any other national exam conducted by the central government departments or their agencies and institutions.

ii. Candidates with B.E./B.Tech./B.Pharma degree or equivalent with excellent academic record (minimum CGPA of 8.00 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 and employees of other organizations with the prior approval and no-objection certificate from their parent organization. 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.

NOTE: In case of Foreign Nationals applying for the Ph.D. programme, candidates need to mandatorily submit VISA permitting research work at TIET.

1.2 TEACHING ASSOCIATESHIP

Category	Teaching Associateship Per Month (Rs)	Remarks
GATE / CSIR-UGC NET or any other national exam conducted by the central government departments or their agencies and institutions	35,000	To be offered to all candidates selected with GATE/NET qualification and will be assigned with teaching load/administrative tasks and designated as Teaching Associates.
Other Candidates	20,000	To be offered only to those candidates with assigned teaching load as per needs of the Department/School or involved in administrative tasks and will be designated as Teaching Associates.

1.3 ELIGIBILITY FOR TEACHING ASSOCIATESHIP

i. Candidates will be considered for Teaching Associateship who are qualified with GATE/NET (UGC/CSIR) or any other national exam conducted by the central government departments or their agencies and institutions. A candidate should have minimum CGPA of 6.0 (10-point Scale) or 60% marks in the qualifying exam.

ii. PhD candidates who are not GATE/GPAT/NET (UGC/CSIR) qualified may also be considered if GATE/GPAT/NET (UGC/CSIR) qualified candidates are not available. Candidates, without GATE/NET (UGC/CSIR), should have minimum CGPA of 6.0 (10-point Scale) or 60% marks in the qualifying exam to be eligible for Teaching Associateship.

iii. **Number of Associateship**: Teaching Associateship are allocated to each Department/School depending upon their teaching load requirement.

iv. **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. In case of GATE/NET qualified candidates, the associateship is extendable to 4th year based on the performance of the research student and the requirement at Department/School level as well as performance of the research student. 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.

v. Emoluments for Teaching Associateship will be ₹35,000/- for GATE/NET (UGC/CSIR) qualified candidates. Emoluments for the candidates with qualified score in GATE / CSIR-UGC NET or any other national exam conducted by the central government departments or their agencies and institutions will be paid from the date of admission.

vi. Emoluments for Teaching Associateship will be ₹20,000/- for candidates who do not have a qualified score in GATE/CSIR-UGC NET (or any other national exam conducted by the central government departments or their agencies and institutions), and will be paid from the date of the admission based on the merit as well as requirements of the respective departments/schools.

vii. A research student who has been selected for the award of teaching associateship:

a) will be given 10-12 hours of teaching load/departmental responsibilities per week.
b) shall not be eligible for any other fellowship from the Institute or from any other source.
c) shall be liable to pay tuition fee and other dues as prescribed by the Institute from time to time.

viii. All the research students shall be eligible for contingency for attending conferences and for consumable expenses as per the rules of the Institute.

1.4 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 **625** Ph.D. candidates are working for their Ph.D. degrees in the Institute).

Dept/School	**Specialization**
BIOTECHNOLOGY	Microbiology/ Molecular Biology
	Drug discovery/plant microbe interaction
	Bioplastics & Biopolymers
	Epigenomics
	Natural Products/ Pharmaceutical Drug delivery systems
	Food Processing
	Microbiome & Metabolic Disease
	Protein Engineering & Downstream Process
CIVIL ENGINEERING	Structural Health Monitoring, Composites in Construction, Sustainable Construction
	By-Products, Sustainable Construction Materials
	Structural Health Monitoring
	Repair and Retrofitting of Structures
	Microbial concrete, Corrosion monitoring and prevention, Sustainable Concrete, Accelerated carbonation curing
	Water Resources Management, contaminant transport in groundwater, flood risk analysis, environmental hydraulics
	Irrigation & Hydraulics
	Hydraulics, environmental hydraulics and water resources Engineering

Dept/School	Specialization
	River hydraulic/ water resources engineering/river training works/remote sensing applications and environmental engineering, environmental hydraulics
	Pavement Engineering, Pavement Preservation, Data Science in Pavement Engineering, Asphalt Chemistry
	Structural Materials
	Structural Engineering, Materials, Repair and Retrofitting of Structures, High Temperature testing
	Sustainable Construction Materials, Corrosion of Structures, Finite Element Modeling, Retrofitting of Structures
	Smart solutions for stability issues related to alternate Geomaterials
	Construction Technology and Composite Structures
	Seismic performance and rehabilitation of structures, Nonlinear performance assessment, Seismic vibration control, Use of smart materials
	Materials in Transportation Engineering
	Pavement materials
	Sustainable Construction Materials, Rebar corrosion protection, Structural Health Monitoring
	Composite structures, retrofitting of RCC structure, natural fiber composite
	Waste characterization and utilisation in building/ pavement materials
	Computer application for construction industry's challenges
CHEMICAL ENGINEERING	Heat transfer and Hydrodynamics of nanofluids, Optimization.
	Thermodynamics and phase transitions of nanoconfined fluids, Nanoporous materials and Adsorption.
	Biopolymers, Polymer–composites and nanocomposites, Graphene, Shear-thickening fluids, Microcellular polymers and its applications, Polymer coatings and Thin film.
	Biodegradable polymers, Porous organic polymers, Sorption, CO_2 capture and utilization, Modeling & Simulation.
	Heterogeneous reaction & catalysis, Photocatalysis, Electrocatalytic oxidation.
	Waste water treatment, Pollution abatement, Separation processes.

Dept/School	Specialization
	Computational fluid dynamics (CFD), Non-Newtonian fluid flow and heat transfer, Local thermal non-equilibrium, Flow and heat transfer through porous media.
COMPUTER SCIENCE & ENGINEERING	Augmented and virtual reality
	Big Data Analytics
	Biomedical signal processing
	Block chain Technology
	Cloud Computing
	Cognitive Computation
	Computational Biology
	Computational imaging and computational photography
	Computer Vision
	Content-Centric Networking
	Cybersecurity
	Deep Learning
	Electric Vehicles
	Image processing
	Internet of Things
	Light Fidelity (Li-Fi) Technology
	Machine Learning
	Multi-agent systems
	Multimedia Processing and Security
	Natural language processing
	Network Security
	Precision agriculture
	Quantum Computing
	Robotics
	Social Media Analytics
	Software Engineering
	Spectral Graph Theory
	Theoretical Computer Science
	Wireless sensor networks
ELECTRONICS & COMMUNICATION ENGINEERING	Fiber Optics Communication, Networking- Wireless/ SDN/Optical, Molecular Communications, Digital Communications, Quantum-Optical Communication
	RFID Antennas, Metamaterials, UWB Antennas, Flexible Antennas, Microstrip Patch Antennas, Etc. For MIMO, Biomedical and Various Other Applications, Food Adulteration Detection, Microwave Engineering, Electromagnetic Metasurface

Dept/School	Specialization
	Wireless Communication, Cognitive Radios, 5G/6G Communication, MIMO Systems, Wireless Sensor Networks, Wireless Network Security, Wireless Communication for IoT, Vehicular Adhoc Network, Internet of Vehicles (IOV), Vanets, Visible Light Communication, Mobile Computing (D2D Communication)
	Signal Processing, Video and Image Processing, Image & Video Forensics, Biomedical Image Processing, Biomedical Signal Processing
	Synthesis Of Nano Particles and Nano Structures, MEMS (Design and Fabrication), Semiconductor Devices and Sensors
	Nano Devices & Modelling, Nanoscale MOSFET Structure for High Scalability and Low Power Consumption, Digital, Analog & Mixed Signal Circuit Design-Automation, VLSI Architectures, VLSI Interconnects, MEMS, Hardware Security, Low-Voltage/Low-Power Design, Device-Circuit Co-Design for IOT Applications
	Machine Learning, Deep Learning, Predictive Control, Nature Inspired Computing, Artificial Intelligence, Computer Vision, Robotics, Ai Sensors Control
	Lightweight Cryptography Algorithms, Quantum Computing, Quantum Communication and Quantum Cryptography, Cyber Security and Network Security,
	Blockchain Technology, Pervasive and Ubiquitous Computing, Cloud Computing, Edge Computing, Digital Twins Technology. Psycho Visual Image Processing, Eye Tracking Analysis, And Geomatics, Information Retrieval, Software Engineering, Optimization, Soft Computing
ELECTRICAL & INSTRUMENTATION ENGINEERING	Artificial Intelligence and its applications
	Biomedical Image Processing
	Biomedical Instrumentation
	Computer Vision
	Control Systems
	Cyber-Physical System
	Cyber and Information Security
	Digital Twin
	Energy System
	IoT and Embedded Systems
	Machine/Deep Learning
	Power Electronics and Drives
	Power Systems
	Process Control

Dept/School	Specialization
	Renewable Energy
	Signal Processing
	Smart & Micro-grid, Electric Vehicles
MECHANICAL ENGINEERING	Processing, characterization, and testing of Polymer Matrix Composites, Metal Matrix Composites, Anti-corrosion coatings, Advanced High Strength Steels
	Thermal spray coating, High temperature corrosion and erosion, Super-alloys.
	Welding and joining of high strength materials such as HSLA, Nuclear Fusion Materials, Inconel super alloys. Friction stir welding and processing, Wire and Arc additive manufacturing (WAAM), Composites. Fabrication of Functionally Graded Material (FGM) via WAAM
	Alternate energy systems, Hydrogen fuel cell technology, materials for energy storage, hybrid energy systems for power applications, heat sinks and thermal management of fuel cells.
	Robotics and Automation: Fabrication and Modelling of Gantry Robot / 6-Axis Robot for 3D Printing of Concretes
	Robotics, Automation and Controls: Mobile robot, Humanoid robot, Exoskeleton, Parallel Manipulator, Nurse robot, Underactuated systems, Modular manipulators
	Human-robot Interaction in Healthcare, Predictive Modeling for Gait Analysis, Deep Learning, and Large Language Models for Healthcare
	Material Deformation, Mechanical Metallurgy, flexible forming techniques.
	CNC Fluid Jet Nano Polishing, Development of Automated CAD and manufacturing system for customized foot insole
	Solar energy and its application in solar desalination, solar refrigeration, solar water heating, solar pond.
	Road Accident Research, Night Driving Studies, Automobile Product Development, Nano Ceramics.
	3D printing of polymers/metals, their characterization, mechanical properties.
	Machine Intelligence for Mechanical Sciences, Prognostics and Data-driven health monitoring
	High temperature oxidation, texture, Thermo-mechanical processing, Material Characterization
	Severe plastic deformation techniques, High speed imaging, Electron Microscopy, Mechanical behavior of material

Dept/School	Specialization
	Two phase flow, heat exchanger thermal analysis, Design optimization of copper grooved tubes used inside condenser/evaporator of room air-conditioner system
	Wave Mechanics, Elastodynamics, Wave Induced Motion, Acoustics
	Computational Fluid Dynamics Modelling of Phase Change Material, Solidification, Heat Transfer Enhancement, Heat Transfer in Porous Media, Sharklet Geometry, CFD modelling of manufacturing Processes
	MEMS, Dynamic behavior of microstructures, Dynamic performance and vibration control of MEMS, Nonlinear Behavior of FGM MEMS Beams, Dynamic Analysis of Composite Materials, Bio-MEMS, Nonlinear dynamics and shape optimization of microbeams
	Computer Assisted tool path planning for multi-axis CNC machining of large scale parametric and faceted engineering surfaces. Development of Mechatronic devices for various bio-medical applications, Development of Nobel materials for wearable sensors using advanced 3D printing applications.
	Active vibration control, Smart structures, Dynamic Analysis of FGM structures, Modelling of additive manufactured structures.
	Additive manufacturing for biomedical application, Biomedical & Biomechanics Engineering
	Automation and robotics, Dynamics and Vibration, Health monitoring
	Nonlinear dynamics, Collisions, Control
	Micro machining, Hybrid composites
	Failure and Damage Mechanics, Uncertainty Quantification, Stochastic Finite Element Analysis, Composite Structures
	Solar Thermal, Nanofluids
	Biomass gasification, dual fuel engine
	Tribology, microwave materials processing, surface engineering, FGM, Nano-lubricants
	Bio-medical Machining
	Bio-heat transfer & fluid flow
	Advanced finishing, MR-Fluids, Automation in smart manufacturing
	Bulk Powder Flow Technology
	Machine Learning, Artificial Intelligence, Industry 4.0 manufacturing systems, Predictive Maintenance, Condition Monitoring, Digital Twin

Dept/School	Specialization
	General Noise and Vibration Engineering, Flow induced vibration, Flutter, Energy harvesting from vibration, Aero-elasticity
CHEMISTRY & BIOCHEMISTRY	Biochemistry : Biophysical Chemistry, Cancer Biology, Diabetes, Drug Development
	Catalysis : Biocatalysis, Electrocatalysis, Nano catalysis, Photocatalysis
	Computational Chemistry: Computational Aided Reaction Mechanism, Computational Catalysis, Computer Aided Drug Design
	Materials: Nanomaterials, Organic Materials, Sustainable Agriculture, 2D Functional Material
	Sensors: Electrochemical Sensors, Nano Sensors, Organic Sensors
	Synthesis: Bioorganic Chemistry, Biotransformation, Medicinal Chemistry, Organic Chemistry, Supramolecular Chemistry
ENERGY & ENVIRONMENT	Policy & Management/ Renewable Energy
	Solid Waste Management
	Biofuels
	Photocatalytic treatment techniques for the removal of emerging contaminants
	Industrial Waste Management
	Advanced Oxidation Process/ Air Quality
MATHEMATICS	Partition Theory, Number Theory, Modular Forms
	Approximation Theory, Functional Analysis, Operator Theory
	Numerical Analysis, Numerical Linear Algebra
	Abstract Algebra, Differential Geometry
	Ordinary Differential equations, Partial Differential equations
	Operation research, Fuzzy Optimization, Duality Theory,
	Application of Ordinary differential equations and mathematical modeling
	Analytic Number Theory
	Computational Fluid dynamics & Scientific Computing
	Machine Learning, Artificial Intelligence, Soft computing
	Mathematical Modeling, Differential Equations, Nonlinear Dynamical Systems
	Statistics
PHYSICS & MATERIALS SCIENCE	Solid state Physics/ Materials Science/ Nuclear Physics/ Environmental radioactivity (Experimental)
	Theoretical Nuclear Physics/Particle Physics

Dept/School	Specialization
	Condensed Matter Theory/ Computational soft condensed matter
	Non-linear dynamics

1.5 APPLICATION FEE : Rs. 1500/-

1.6 SELECTION PROCESS

i. 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.

ii. Relaxation for appearing in the entrance test will be given by the institute to those candidates who have qualified GATE / CSIR-UGC NET or any other national exam conducted by the central government departments or their agencies and institutions.

1.7 IMPORTANT DATES

Last date for receipt of completed application forms : December 21, 2024

Date for issuing the admit card through registered email ID : December 23, 2024

Entrance Test to be conducted by TIET

Departments	Date of Entrance Test	Time of Entrance Test
Department/ School		
Biotechnology	December 26, 2024	09:00 AM
Chemical Engineering	December 26, 2024	11:00 AM
Computer Science and Engineering	December 26, 2024	09:00 AM
Civil Engineering	December 26, 2024	01:00 PM
Electrical & Instrumentation Engineering	December 26, 2024	01:00 PM
Electronics & Communication Engineering	December 26, 2024	03:00 PM
Mechanical Engineering	December 26, 2024	09:00 AM
Physics & Materials Science	December 26, 2024	11:00 AM
Humanities & Social Sciences	December 26, 2024	09:00 AM
Mathematics	December 26, 2024	01:00 PM
Energy and Environment	December 26, 2024	01:00 PM
Chemistry & Biochemistry	December 26, 2024	03:00 PM

Display of Result of Entrance Test : December 30, 2024

Entrance Test for Ph.D. programme shall be conducted ONLINE/OFFLINE by respective departments/schools and the candidates will be informed accordingly.

Admit card will be sent to the candidates through registered email ID filled in the application form. Candidates are advised to check their email (including Junk/Spam) regularly for any updates.

Date of interview for Ph.D. will be declared later on by the respective department/school.

1.8 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.

1.9 COURSE WORK AFTER SELECTION TO PhD PROGRAMME

i. Every admitted candidate (Regular/Part-time) shall have to take upto 36 credits of course work during his/her entire tenure of PhD. However, the student will be allowed to submit the research proposal after successful completion of 12-16 credits of course work that shall include at least four courses, namely,
   a) 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),
   b) a professional course (if not offered by any Department/ School, its syllabus to be proposed by the allocated supervisor and approved by DoAA), and
   c) a seminar (relevant in the area of research).
   d) A course on Research and Publication Ethics

ii. The process of registration in the course work, examination, evaluation and grading shall be same as followed for UG/PG programmes.

iii. 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.

1.10 PROCESS FOR SUBMISSION OF RESEARCH PROPOSAL

i. After successful completion of the 12-16 credits of course work, every candidate will be required to submit research proposal, duly recommended by the Supervisor(s), 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.

ii. 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.

iii. 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.

iv. 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.

1.11 ADDITIONAL INFORMATION ON APPLICATION/SELECTION PROCESS

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 Physically Challenged 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 The students who qualify the entrance tests of the following Departments/Schools are also eligible for appearing in interview for Ph.D. admission in Chemical Engineering

- Department of Mechanical Engineering
- Department of Biotechnology
- School of Chemistry and Biochemistry
- School of Environment and Energy

1.12 INSTRUCTIONS FOR ENTRANCE TEST

1 Entrance Test for Ph.D. programme shall be conducted ONLINE by respective departments/schools.

2 The Admit Cards for 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 Entrance Test shall contain 80 objective type questions. Duration of the Entrance Test will be 90 minutes.

4 The total marks of the test will be 80.

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

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

7 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

English
Interpersonal skills including communication skills, anonyms/synonyms, sentence completion, active/passive voice, prepositions, direct/indirect speech, idioms & phrases.

Quantitative Reasoning
Ratios and proportion, percentages, profit & loss, averages, partnership; time-speed-distance, work and time; number system, factors, multiples; pipes and cisterns, simple interest & compound interest, installment payments; clocks, calendar; in-equations, quadratic and linear equations, functions, logarithm geometry, mensuration and solid geometry, geometry (lines, angles, triangles, spheres, rectangles, cube, cone etc), co-ordinate geometry.
Set theory, measures of central tendency and dispersion, probability and theory random variables (single variable case only), probability distribution (binomial, poisson and normal), correlation & regression; permutation & combinations; maxima & minima, progression; complex numbers; data Interpretation based on text, graphs (column graphs, bar graphs, line charts, Pie charts, graphs representing area) and tables.

Analytical Reasoning & Mental Ability
Critical reasoning, visual reasoning, assumption-premise-conclusion, assertion and reasons; statements and assumptions, identifying valid inferences, identifying strong arguments and weak arguments, statements and conclusions; cause and effect,

identifying probably true, probably false, definitely true, definitely false kind of statement; linear arrangements, matrix arrangements, puzzles, family tree problem, symbol based problems; coding and decoding, sequencing, identifying next number in series, etc; tables. Basic numeracy (numbers and their relations, orders of magnitude, etc.)

CIVIL ENGINEERING DEPARTMENT

NOTE: There are four sections (Specializations) in the syllabus

i. Structural Engineering
ii. Geotechnical Engineering
iii. Water Resource and Environmental Engineering
iv. Transportation Engineering

Candidates can choose ANY ONE of the FOUR sections (specializations) viz. Structural Engineering OR Geotechnical Engineering OR Water Resource and Environmental Engineering OR Transportation Engineering depending upon his/her area of specialization in Masters Degree programme. A candidate has to attempt 80 compulsory questions from the chosen section.

Section 1: STRUCTURAL ENGINEERING

Strength of materials: Bending moment and shear force in statically determinate beams. Simple stress and strain relationship. Simple bending theory, flexural and shear stresses, 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 (Macaulay's double integration method, moment area theorem, conjugate beam method, unit load method and Castigliano's theorem) and analysis of statically indeterminate structures by force/ energy methods (Method of Consistent Deformations and Three Moment Theorem), analysis by displacement methods (slope deflection and moment distribution methods), influence lines for determinate.
Concrete Structures: Concrete Technology- properties of concrete, mix design as per IS 10262:2019. Concrete design- basic working stress and limit state design concepts, design of members subjected to flexure, shear, compression and torsion by limit state methods. Design and reinforcement detailing of building frames. ·Basic elements of prestressed concrete, analysis of beam sections at transfer and service loads. Fundamentals of earthquake, IS1893: 2016 and IS 13920:2016 concepts.
Steel Structures: Analysis and design of tension and compression members, column bases. Connections- simple and eccentric, design of welded and bolted joints (lap joint, butt joint), beam-column connections
Surveying: Levelling and contour, theodolite traversing, plane table surveying, Principles of total station, GPS survey, concepts of remote sensing

Section 2: GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils, soil classification, three-phase system, fundamental definitions, phase relationships, clay minerals, permeability, seepage, effective stress principle, capillarity, stress due to surface load, compaction, consolidation, 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, backfill inclination. Stability of retaining walls, MSE walls. Stability of slopes - infinite slopes, finite slopes, method of slices, total stress analysis, sudden drawdown condition. 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.
Surveying: Levelling and contour, theodolite traversing, plane table surveying, Principles of total station, GPS survey, concepts of remote sensing

Section 3: WATER RESOURCES & ENVIRONMENTAL ENGINEERING

Fluid Mechanics: Properties of fluids, fluid statics; Forces on immersed bodies; Continuity, momentum and energy equations and their applications; Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth; Concept of lift and drag.
Hydraulics: Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and water surface profiles.
Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, infiltration, unit hydrographs, hydrograph analysis, reservoir capacity, discharge measurement in rivers, peak flood estimation, flood routing, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's Law.
Irrigation: Types of irrigation systems and methods; Crop water requirements - Duty, delta, consumptive use; Gravity Dams and Spillways; Lined and unlined canals, Design of weirs on permeable foundation; cross drainage structures.
Water and Waste Water Quality and Treatment:
Basics of water quality standards – Physical, chemical and biological parameters; Water quality index; Unit processes and operations; Water requirement; Water distribution system; Drinking water treatment. Sewerage system design, primary and secondary treatment. Effluent discharge standards; Sludge disposal; Reuse of treated sewage for different applications.
Basics of remote sensing and GIS: EM spectrum, signatures, errors, Image classification, map and projection system.
Surveying: Levelling and contour, theodolite traversing, plane table surveying, Principles of total station, GPS survey, concepts of remote sensing

Section 4: TRANSPORTATION ENGINEERING

Highway Infrastructure: Geometric design of highways, testing and specifications of paving materials, design of flexible and rigid pavements as per IRC codes.
Traffic Engineering: Traffic characteristics, theory and parameters of traffic flow, types of intersection, traffic signs and signal design, highway capacity.
Construction Management: Types of contracts, project planning and network analysis - CPM and PERT, estimation and costing
Surveying: Levelling and contour, theodolite traversing, plane table surveying, Principles of total station, GPS survey, concepts of remote sensing

COMPUTER SCIENCE AND ENGINEERING DEPARTMENT

Quantitative Aptitude: Number Systems, Fractions, Decimals, Percentages, Ratio and Proportion, Averages, Simple and Compound Interest, Time and Work, Time, Speed, and Distance, etc. Data interpretation: Graphs and charts, tables, data sufficiency, data analysis, data comparison, etc.

Introduction to programming: Fundamentals of C Language, Functions, Arrays and Pointers, Strings, Structures and Unions, Input/Output, file input/output, and formatted I/O, Dynamic memory allocation, Preprocessor directives, Bitwise operations and bit fields, Library functions: mathematical functions, time and date functions, and string handling functions, Typecasting, type conversions, and type compatibility, Error handling.

Introduction to OOP: Basic concepts, Class design and object-oriented modelling, Abstraction, encapsulation, and data hiding, Inheritance and polymorphism, Exception handling, Collections: lists, sets, maps, and dictionaries, GUI programming: basics of GUI programming, event-driven programming, and event handling.

Data Structure: Stack, Queue, Linked List, Tree, Graph, Searching, Sorting & Hash Faction.

Operating Systems: Introduction and System Structures, Process Management, Deadlock, Memory Management, File Systems, Disk Management, Protection and Security, Concurrency.

Algorithm Analysis & Design: Introduction to Algorithm Analysis, Brute Force and Exhaustive Search Algorithms, Divide and Conquer Algorithms, Greedy Algorithms, Dynamic Programming, Backtracking and Branch and Bound, Randomized Algorithms, Advanced Data Structures and Algorithms, Complexity Theory and NP-Completeness, Emerging Trends in Algorithm Design

Database Management System: Introduction to Database Systems, Data Models, SQL (Structured Query Language), Relational Database Design, Transaction Management, Storage and Indexing, Database Security, Data Warehousing and Data Mining, NoSQL databases and Big Data, Emerging Trends in Database Systems

Software Engineering: Requirements Engineering, Software Design and construction, Software Verification and Validation, Software Project Management, Analysis, Formal specification, CASE Tools, Software Business Process Reengineering, Configuration Management.

Computer System Architecture: Introduction to Computer Systems, Processor Architecture, Memory System Architecture, Input/Output Systems, Storage Systems, Network and Distributed Systems, Parallel Processing and Multicore Systems, Embedded Systems and Real-Time Systems, Emerging Trends in Computer Systems

Compiler Construction: Lexical Analysis, Parsers (LL and LR), Semantic Analysis, Run Time Environment, Intermediate Code Generation, Code optimization

Computer Networks: Physical Layer, Data Link Layer, Network Layer, Transport Layer & Application Layer.

Theory of Computations: Regular Expressions, Finite Automata, Push Down Automata, Turing Machines, Chomsky hierarchy, P and NP type of problems

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

NOTE: There are two sections in the syllabus A. Aptitude and Basic Electronics B. Specialization. Section A comprising of 40 questions is compulsory for everyone. Section B has 3 options: 1. Communication Systems, 2. VLSI devices, circuits and systems and 3. Computing Technologies and Candidates can choose to attempt questions (40 questions) from any one of the three options.

Section A: Aptitude and Basic Electronics (Compulsory - 40 Questions)

Quantitative and analytical aptitude.

Thevenin, Norton, Superposition and Maximum Power Transfer theorems, time domain analysis of simple RLC circuits, frequency domain analysis of RLC circuits, two-port network parameters.
Diode characteristics and its equivalent circuits, simple diode circuits: clipping, clamping, rectifier, biasing of BJT and FET, simple op-amp circuits, filters, oscillators, SCR, Gunn diode, PIN diode.
Number system, Boolean algebra, logic gates, simplification of Boolean function, combinational circuits, latches, flip-flops, counters and shift registers.
Gauss and Strokes theorems, Maxwell's equations: differential and integral forms, gradient, divergence and curl, wave equation, Poynting vector.
Microcomputer architecture, Intel 8085 architecture, addressing mode, instruction set.

Section B: Specialization (Choose any 1 out of 3 options - 40 Questions)

Option 1: Communication Systems

Continuous and discrete time signals and systems, sampling theorem, causality, stability, impulse response, convolution, LTI systems: definition and properties, z-transform, Fourier series, continuous time Fourier transform, DTFT, DFT.
Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, super heterodyne receivers.
Digital communications: PCM, DM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, matched filter receiver, SNR and BER.
Information Theory and Coding: entropy, mutual information and channel capacity theorem, source coding, channel coding.

Option 2: VLSI Devices, Circuits and Systems

Digital IC circuits, implementation of Boolean functions, 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, static timing analysis. Basics of semiconductor physics, MOS transistor theory, equivalent MOSFET models, CMOS process from designers view and layout considerations, CMOS circuit characterization and performance estimation, CMOS Logic structures, basics of analog IC design, short channel effects, low power VLSI design techniques, fundamentals of VLSI testing, concepts of hardware description languages, types of memory, ROM, RAM, PAL, PLA, PLD, CPLD etc. memory hierarchy, 8085/8086 microprocessor architecture, instructions set and interfacing, microcontroller and FPGA architectures.

Option 3: Computing Technologies

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.
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.
General Computing: 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.

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.

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 inferential 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

NOTE: There are four sections in the syllabus

v. Mechanical Design
vi. Manufacturing Processes
vii. Thermal and Fluid Engineering
viii. Interdisciplinary and Scholastic Aptitude.

Candidates can choose to attempt questions from any one of the first three main sections viz. Mechanical Design OR Manufacturing Processes OR Thermal-Fluid Engineering. Questions from the last section (Interdisciplinary and Scholastic Aptitude) will be compulsory for all.

i. 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.

Basics of mechatronics and control systems, robotics, vehicle dynamics.

OR

ii. 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.

OR

iii. Thermal-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, black body radiation, heat exchangers.

iv. Interdisciplinary and Scholastic Aptitude (Compulsory Section)

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.

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, laws 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.