10. PhD PROGRAMME

(i) A candidate seeking admission to the degree of Doctor of Philosophy must have obtained ME/MTech/MPhil/MCA/MSc/MA/MBA/CA or equivalent with minimum CGPA of 6.00 on a 10 point scale or 55% marks in aggregate where marks are awarded or NET (UGC/CSIR) qualified.

(ii) Candidates with BE/BTech 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 BE / BTech 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 BE/BTech or equivalent qualification will be admitted for PhD after successful completion of eight Masters level courses as suggested by the PhD 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 professionally employed personnel. 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 PhD 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 PhD Program. 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 University. **The candidates who secure minimum of 20% 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 may be given by the University to those candidates who have

qualified UGC/CSIR (JRF).

(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 PhD 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 URB, she may resubmit it within next six months starting the date of meeting of URB failing which her/his admission will be cancelled.

Notes:

(a) Part-time candidates are required to submit the "**No Objection Certificate**" from their parent organization/department/employer stating that the candidate is permitted to pursue studies on a part-time basis and that the candidate's official duties permit her/him to devote sufficient time for course work and research.

(b) In case of FN candidates, Research VISA endorsed to TU is required.

10.1 GENERAL INFORMATION

TU offers PhD programme in almost all specializations of Engineering, Technology, Management and Sciences in the following Departments/Schools of the University (currently around 623 PhD candidates are working for their PhD degrees in the University).

DEPARTMENTS

Biotechnology Department

Agro-Biotechnology, Plant Biotechnology, Bioremediation, Microbial Ecology, Food Technology, Food process and Safety, Plant Microbe Interaction, Tissue culture, Sustainable Agriculture, Bioinformatics, Areas of Animal Biotechnology & drug discovery and Microbial Concrete.

Chemical Engineering Department

Modeling and Simulation, Catalysis, Environment Pollution, Polymers and Composities, Mass Transfer, Bio-Chemical Engineering, Heat Transer, Nanofluids, Nanocomposites, Pulp and Paper, Energy Management, Membrane Separation.

Civil Engineering Department

Structural Engineering, Geo-technical Engineering, Transportation Engineering, Construction Engineering and Management and Computer Aided Design, Water Resource Engineering.

Computer Science & Engineering Department

Parallel and Distributed Computing, Software Engineering, Network and Information Security, Soft Computing, Wireless and Sensor Networks, Theoretical Computer Science.

Electrical & Instrumentation Engineering Department

Optimal Power System Operation, Electric Drives, Application of FACTS, Power Electronics, Process Control & Instrumentation, Artificial Intelligence Applications, Biomedical Instrumentation, Embedded systems, Virtual Instrumentation, Control System.

Electronics & Communication Engineering Department

RF Devices, Antennas and Micro-wave integrated circuits, solid State & thin films, Digital Signal processing;VLSI, Wireless Communication, Optical Communication, Opto Electronics.

Mechanical Engineering Department

Heat Transfer, IC Engines, Energy Conservation and Management, Bearings & Lubrication, Computer Aided Analysis & Design, Industrial Engineering, Robotics and Vehicle dynamics,Modellingof multibody systems, Fluid Mechanics, Technology Management, Materials and Metallurgy, Production Engineering, Manufacturing Engineering.

SCHOOLS

School of Physics & Materials Science

Solid State Physics, Materials Science, Nano Science, Liquid Crystal,Electro ceramics Smart Materials, Magnetic Material, Condensed Matter Physics, Nuclear Physics.

School of Humanities and Social Sciences

Industrial Management, Business Economics, Intellectual Property Rights, E-Business, Finance, Organizational Behavior, Cognitive & Experimental Psychology

School of Mathematics & Computer Applications

Operations Research; Functional Analysis; Reliability; Fourier Analysis; Differential Equations; Algebra; Soft computing; Theory of Elasticity; fuzzy sets; Number Theory; Astrophysics; Software Engineering, Cloud computing; Natural language processing; Multimedia security; Cryptography; Cellular Automata; Computer Networks; Image Processing.

School of Chemistry & Biochemistry

Analytical Chemistry, Organic Chemistry, Organometallic Chemistry, Environmental Chemistry, Medicinal Chemistry/Inorganic Chemistry/ Photocatalysis/ Nanomaterials/ Bio-physical Chemistry.

L M Thapar School of Management

International Business, Innovation Systems, Economics, Information Systems, Strategic Management, IPR, Supply chain management, Corporate Finance, Investment Management

School of Energy and Environment
Environmental Technology & Management, Environmental Engineering, and Bioremediation.

10.2 Number of Seats available for first semester of session 2015-16: Candidates are advised to browse www.thapar.edu for updated information about any further availability of seats for PhD.

Departments	No. of Seats	Specialization
Biotechnology		
	01	**Microbiology**
	01	**Plant Biotechnology**
	02	**Bioremediation**
Chemical Engineering		
	01	**Modelling & Simulation**
	01	**Polymers; Adsorption**
	02	**Modelling & Simulation, Waste & Water treatment**
	01	**Waste & water treatment**
	01	**Environmental Engineering**
	01	**Membrane separation**
	01	**CFD Modelling & Simulation**
	01	**Thermodynamics and Molecular Modelling**
	02	**Nanomaterials &Photocatalysis**
	02	**Bio-separation, waste water treatment**
	02	**Polymeric coatings, modeling & simulation, energy**
Civil Engineering		
	02	**Structural Materials**
	05	**Water Resources**

	04	Structures
	01	Geotechnical
Computer Science & Engineering		
	02	Algorithms and Machine Learning
	02	Grid and Cloud Computing, Big Data, Software Engineering
	02	Computer Networks
	01	Big Data Mining & Analysis
	01	Formal languages, Software Testing, Theoretical Computer Science
	01	Bio Data, Machine learning
	01	Natural Language Processing, Machine Learning
	01	Computer systems organization, Distributed computing methodologies
	01	Image Processing
Electrical & Instrumentation Engineering		
	03	Biomedical & Instrumentation
	01	Power Systems/ Head up display
	02	Power System
	02	Biometrics, Signal & image processing Control System
	02	Embedded Systems, Biomedical Instrumentation, Signal & Image Processing
	06	Power Electronics
	01	Power System (Micro grid)
	02	Smart Grid, Renewable Energy Sources, Micro-grid
	02	Machine Learning, Speaker Recognition, Pattern Recognition
	02	Protection of transmission line and machines
	01	Digital Image Processing
	03	Power System Operation and Control, Intelligent System
Electronics & Communication Engineering		
	05	Fiber Optical Communication
	03	Antenna Design & Wireless Communication
	01	Signal Processing & Wireless Communication
	02	ASIC/VLSI Circuit & System Design
	03	Signal Processing and Antenna Design
	01	Opto Electronics, Nano Photonics
	01	Fiber Optic Communication
	01	Wireless Communication and Signal Processing
	03	Image & Video Processing
	02	Wireless Network Security
	02	Wireless Communication and Antenna System
	03	Digital Signal Processing
	03	Analog CMOS IC Design
	02	VLSI Interconnects
	02	MEMS Design and Fabrication

	01	High Power RF Design & Fabrication
	1.5	Image & Video Processing, Signal Processing
	03	Wireless Communication
	03	Antenna & Wireless Communication
Mechanical Engineering		
	01	Ultrasonic Assisted Electrical Discharge Machining of Hard Metals and Ceramics
	01	Solar Thermal Systems, Two-phase Flow & Heat Transfer, Dual Fuel Internal Combustion Engine
	02	Computational fluid Dynamics, Erosion wear, Solid- liquid two phase flow
	03	Dynamics and Analysis of manufacturing process, FEM and Analysis of Sheet Metal Forming, Rapid Prototyping, Welding process modeling and analysis, Analysis of Conventional and Non-Conventional Material Removal Process
	02	Robotics and Control, Vibration Suppression
	01	Tribology/Nanotribology, Design of tribo-elements, Nanocomposites, Materials Characterization
	01	FEM and Polymer Composites
	02	Machining dynamics (dynamics in manufacturing process), vehicle dynamics, robotics and control
	03	Magnetorheological Nanofinishing Processes
	02	Bulk Solids Storage and Transport Processes
	01	Manufacturing
	01	Composite Materials and Industrial Metallurgy
	01	Processing of Composite Materials
Schools		
School of Physics & Materials Science		
	08	Condensed Matter Physics (Experimental)
	01	Materials Science
	01	Nonlinear Optics, Photonics
	01	Thin film Solar Cells
School of Humanities & Social Sciences		
	02	Cognitive, Experimental & Neuropsychology
	02	Economics/ Management/ Finance and Commerce
	03	HRM, HRD, Communication Skills, General Mgt.
	01	Organizational behavior, social psychology, counseling
	02	Psychology (counselling and human development)
	01	English (English Literature)

School of Mathematics & Computer Applications		
	01	**Functional Analysis (Fixed Point Theory and Applications)**
	01	**Differential Equations**
	01	**Mathematical Programming/ Operations Research**
	01	**Numerical Analysis**
	01	**Elasticity**
	01	**Computer Networks/ Software Engineering**
	01	**Number Theory (Partition Theory)**
	02	**Data Authentication using Cellular Automata**
	01	**Natural Language Processing**
	02	**Information Security**
	01	**Fixed Point Theory**
	01	**Operations Research**
	02	**Big Data & Analytic, Social Networking**
School of Chemistry & Biochemistry		
	02	**Heterogeneous catalysis and Nanomaterials**
	02	**Metal-semiconductors Nanocatalysis and photocatalysis**
	01	**Biological Chemisrty**
	01	**Organic Chemistry**
	01	**Catalysis**
	03	**Biophysical, Bio-inorganic and Biochemistry**
	03	**Synthetic Organic and Medicinal Chemistry**
	02	**Organic Synthesis and Medicinal Chemistry**
	02	**Organic & Supramolecular Chemistry**
	02	**Advanced Nanomaterials for Catalysis**
	02	**Inorganic and Organometallic Chemistry**
LMT School of Management		
	03	• **Strategy, Sustainability & Society** • **Behavioral Decision Science** • **Quantitative Culture Studies** • **Academic & Corporate Leadership**
School of Energy and Environment		
	02	**Waste Water treatment**
	01	**Industrial wastewater treatment**
	01	**Solid Oxide Fuel Cells**
	02	**Environmental Hydrology and water resources management**

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

10.3 The application form along with attested copies of certificates must be submitted to the 'Incharge Admission Cell" on or before the specified dates for the odd semester and even semester. Incomplete application forms and

those received after the prescribed date will not be entertained under any circumstances. No correspondence/enquiry from such candidates shall be entertained.

No separate intimation will be sent regarding conduct of exam, Interview and start of session. Application form must accompany:

(*i*) Attested copies of the certificates of the examinations passed.

(*ii*) One passport size photograph pasted on the application form in the space provided for the purpose.

10.4 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.

10.5 TEACHING ASSOCIATESHIP

i Eligibility

The associateship may be granted to candidates out of those admitted to the PhD (Regular) programme. Only those candidates will be considered who have obtained minimum CGPA of 6.75 (10.00 point scale) or first division in their qualifying examination. Teaching associateship is also available to full time Ph.D students admitted to engineering department having B.E/ B.Tech qualification under TEQIP (subject to availability of funds).

ii Number and Values of the Associateship

Teaching Associateship are allocated to each Department/School depending upon their requirement. The numbers of Teaching Associateship vary from time to time.

Emoluments for the Teaching Associateship will be ₹13,000/- (including contingency) per month or as approved from time to time by the University.

Suitable accommodation may be provided, if available in the University on rental basis.

iii Duration

The associateship will be tenable for one semester at the first instance from the date of selection, to be renewed after every semester as per requirement of the Deptt./School.

iv 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 University 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 University from time to time.

GENERALINFORMATION REGARDINGPhDENTRANCETEST

- The duration of test shall be 1 ½ hours.
- It will be offline mode.
- Entrance exam will contain 75 questions.
- The questions will be of MCQ type.
- The total marks of the test will be 75.
- There will be a negative marking for every wrong answer ¼ marks will be deducted.
- The test will be taken in the concerned subject area
- Cut off marks in the entrance test will be 20% (15% for SC/ST) of the total marks.

PhD entrance examination syllabus

i) 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

ii) Department of Chemical Engineering

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 equipments; 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 and microbial growth kinetics, bioreactor analysis

iii) Department of Civil Engineering

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 modeling. 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, leveling, theodolite traversing, plane table surveying, errors and adjustments, curves.

IV) Computer Science and Engineering Department

Section A: Total Questions-15
***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: Total Questions-15
***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: Total Questions-45
***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.

V) 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;

VI) 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.

VII) INSTRUMENTATION & CONTROL ENGG.

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.Instrumentationamplifier.Precisionrectifier.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. A.C & D.C current probes. Extension of instrument ranges. Q-meter and waveform analyser. 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 fiber optics. Biomedical instruments, EEG, ECG and EMG. Clinical measurements. Ultrasonic transducers and Ultrasonography. Principles of Computer Assisted Tomography.

VIII) MECHANICAL ENGINEERING DEPARTMENT

Heat Transfer; I.C Engines; Power Plant Engineering; Automobile Engineering; Tribology; Computer Aided Analysis & Design; Industrial Engineering; Engineering Materials, Robotics; Fluid Mechanics; Non Traditional Machining; Vibrations; Mechatronics; Automation; Modeling and Simulation; Two-phase Flow; Renewable Energy.

IX) School of Chemistry and Bio-Chemistry

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 chain polymerization.
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.

X) School of Energy and Environment

a) For Environment Science and Technology the entrance examination will be of two sections:

(1) **Environment Sciences**: Environmental microbiology; Ecology, Environment chemistry; Environment pollution, Environment technologies.

(2) **Environment Technology:** Environment quality monitoring; Water and wastewater treatment technology I & II (Physico-chemical and Biological); Air pollution control technology; Solids and hazardous waste management.

b) For Energy Technology and Management examination the following syllabus has been framed:

(1) **Energy Technology:** Energy resources; Conventional energy technology; Fuels and combustion; Solar energy; Biofuels; Heat transfer and Thermodynamics; Fluid mechanics and hydraulics; Wind Energy.

XI) SCHOOL OF HUMANITIES & SOCIAL SCIENCES

Syllabus PhD (Psychology)

Developmental Psychology, Personality, Experimental Psychology, Cognitive Psychology, Physiological Psychology, Psychopathology, Psychodiagnositics, Psychometrics, Guidance and counseling ,Psychological assessment, Neuropsychology, Psychotherapeutic techniques ,Research methods and Statistics & Industrial Psychology

Syllabus for PhD (Economics/Management / Finance and Commerce)

Micro Economics, Macro Economics, Indian Economy; Research Methodology and International Business, Finance and accounting.

Syllabus for PhD (Human Resource 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 PhD (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

XII) School of Mathematics and Computer Applications

Mathematics

Note: Candidates seeking admission in mathematics are required to attempt any four 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.

Computer

Discrete Structures: Sets & Relations - Reflexivity, symmetry, transitivity, equivalence; Functions - Determining complexity of a program, hashing functions, recursive function; Basic Logic -Propositional logic, logical connectives, truth tables, normal forms, proof by contradiction, induction over natural numbers, structural induction, weak and strong induction;**Graph and Tree** - Introduction to graphs, graph terminology, graph isomorphism, directed and undirected graphs and their representations; Paths, Reachability and connectedness; Basic concepts of trees and spanning tree; Lattice; Boolean Algebra.

Programming in C: C characteristics - Pre-processors and macros, data types, expressions, operators and their precedence; Looping Constructs - *while* loop**,** *do…while* loop**,** for loop**,** nesting of loops;**Conditional Statems -** *if-else* statement**,** nested *if-else* statement**,** *switch* statement, conditional

operators;**Functions and procedures; Arrays and strings; Structures and union; Pointers; File handling functions.**

Data Structures: Algorithm complexity and Big O notation; Linked Lists - Single, circular and double linked list; Stacks and queues representation as list and array, priority queues, deques; Binary trees - Array and dynamic representations, threaded binary trees, AVL trees; Searching and sorting algorithms, B-trees, B+- trees, Hashing; Graphs - DFS, BFS, shortest path algorithms.

Operating System: Fundamentals; Types; P**rocess Management-CPU scheduling; Process Synchronization-Algorithmic solutions, semaphore, hardware solutions; Deadlock-prevention & detection, recovery; Memory Management- Paging, segmentation; Virtual memory- Thrashing; File Management; Input/Output management** .

Computer Networks: Categories of Computer Network, Network topologies, Networking hardware, Network media, Networking Addresses - Physical addresses, IPv4, IPv6, domain addresses; TCP/IP Reference model - Functionalities of different layers and their protocols, comparison with OSI reference model; Broadcasting and multicasting communication, Search engines, Basic internet applications.

Algorithm Analysis & Design: Algorithm definition, analysing algorithms, order arithmetic, time and space complexity, principles of algorithm design; Algorithmic Strategies - Greedy, divide-and-conquer; **Dynamic Programming -** Use of table instead of recursion, longest common sequence, all pair shortest path, 0/1 knapsack problem, optimal binary search tree, shortest-path algorithms, minimum spanning tree; **Backtracking -** 8 queens problem, sum of subsets, graph coloring, knap sack problem; **Lower Bound Theory -** Comparison trees for sorting and searching, oracles and adversary arguments, techniques for algebraic problems.

XIII) 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.