இந்திய தகவல் தொழில்நுட்பக் கழகம், திருச்சிராப்பள்ளி
भारतीय सूचना प्रौद्योगिकी संस्थान, तिरुचिरापल्ली
INDIAN INSTITUTE OF INFORMATION TECHNOLOGY TIRUCHIRAPPALLI
(An Institute of National Importance under MoE, Govt. of India)
SETHURAPATTI, TRICHY-MADURAI HIGHWAY, TIRUCHIRAPPALLI 620012
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Ph.D. PROGRAMME 2025 - 2026 (JULY SESSION)

ADMISSIONS TO THE PHD PROGRAMME UNDER INSTITUTE & VISVESVARAYA PHD SCHEME

Indian Institute of Information Technology Tiruchirappalli (IIITT) is one among the 20 IIITs established under the non-profit Public-Private Partnership (PPP) Model by MoE, Government of India, through an Act 74 of 2017 of Parliament. The Institute was established in the year 2013-14. IIITT is an Institute of National Importance and Autonomous Academic Institute funded by Govt. of India, Govt. of Tamil Nadu, and Industry Partners. Industry Partners of IIITT include Tata Consultancy Services (TCS), Cognizant Technology Solutions (CTS), Infosys, Ramco Systems, Electronics Corporation of Tamil Nadu Limited (ELCOT), and Navitas (Take Solutions).

Indian Institute of Information Technology Tiruchirappalli (IIITT) offers Ph.D programs in the following Departments.

Department	Specialization
Computer Science and Engineering	Data Analytics, Artificial Intelligence, Machine Learning, Deep Learning, Generative AI, Image & Video Processing, Medical Image Processing, HCI, IoT, Block chain, Information Security, Cyber Security, Remote Sensing & GIS, Natural Language Processing, Computer Vision, Digital Agriculture, LLM Models and any other emerging area related to CSE discipline
Electronics and Communication Engineering	VLSI Design, ASIC & FPGA system design, RF & Microwave, Optical communication, Micro & Nano Electronics, Device Modeling & Simulation, Wireless Communication, Communication Networks
Mechanical Engineering	Additive Manufacturing, Smart Materials, Energy Storage Materials and Devices

Science and Humanities: Physics	Optoelectronic Materials & Devices, Fiber optics, Plasmonics, Semiconductor hetero-structures, Graphene based biosensors
Mathematics	Fluid Dynamics, Machine Learning
English	Applied Linguistics, English Language Teaching

Candidates are permitted to register for the Ph.D. programme in interdisciplinary areas related to circuit branches.

The Visvesvaraya PhD scheme details are as follows:

Fellowship: 5 Nos (Full-Time - 4 & Part-Time -1) are available under the Visvesvaraya Ph.D. Scheme for the following Departments.

Department / Programme	**Number of Full-Time fellowships**	**Number of Part-Time fellowship**
Electronics and Communication Engineering & Computer Science and Engineering	2	1
Chip to Startup Programme (C2S)	2	

Financial Support for PhD Candidates under Visvesvaraya PhD Scheme:

Full-Time:

- **Fellowship:** Rs. 38,750/- per month (1st and 2nd year);
  Rs. 43,750/- per month (3rd to 5th year, subject to satisfactory progress)
- Fellowship is provided until PhD completion or a maximum of 5 years, whichever is earlier.
- **Research Contingency Grant** support of ₹ 1,20,000/- per year / PhD candidate
- **Rent Reimbursement** (as per Government of India norms)
- Candidates admitted under the Visvesvaraya Ph.D. scheme will be governed by the guidelines issued by the Ministry of Electronics and IT (MEITY), Govt. of India. For additional details visit https://phd.digitalindiacorporation.in/home

Part –Time:

- Part-time PhD candidates get one time incentive of **Rs. 3,00,000/-** on successful completion of PhD degree

1. ADMISSION CATEGORIES

Candidates will be admitted to the Ph.D. programme of the Institute under one of the following modes:

a) **Full-Time:** Regular full-time scholars without fellowship / JRF fellowship / Sponsored scholars being employees of Defense organization, Research & Development organization, a private industry /institution having MoU with IIIT Tiruchirappalli.

b) **Part-Time:** Regular / Full-time teachers / employees working in Govt./ Govt. aided /Private Engineering/ Technology colleges or Science and Arts Colleges/ Universities / Industry / Public sector organizations are considered under this category. At the time of application, the candidate must submit a 'No Objection Certificate' from the Parent College / Organization.

2. ELIGIBILITY

2.1 Ph.D. in Engineering

a) Candidates with Master's degree in Engineering/ Technology or a Master's degree by Research (M.S. By Research) in Engineering/ Technology disciplines with a minimum of 60% aggregate marks (or) CGPA of 6.5/10 in UG or PG for admission under OC/OBC candidates and 55% aggregate marks or equivalent CGPA of 6.0/10 for SC/ST candidates.

b) Candidates with Bachelor's degree in Engineering/ Technology with valid GATE Score with a minimum of 90% aggregate marks (or) CGPA of 9.5/10 in UG for admission under OC/OBC candidates and 85% aggregate marks or equivalent CGPA of 9.0/10 in UG for SC/ST candidates.

c) Candidates with Bachelor's degree in Engineering/ Technology with 15 years of proven experience in reputed industries are also eligible.

2.2 Ph.D. in Science & Humanities (Mathematics/ Physics / English)

Candidates with First class Bachelor or First class Master degree in Sciences/Humanities in the relevant discipline with minimum 60% aggregate marks (CGPA 6.5/10) in UG or in PG for OC/OBC category and 55% aggregate marks or equivalent CGPA of 6.0 in UG / PG for SC/ST candidates.

3. SELECTION PROCEDURE

a) Eligible candidates possessing the minimum educational qualifications and satisfying additional criteria set by the Institute for Full-Time and Part-Time from time to time will be called for written test and interview by the selection committees of the respective departments.

b) The written test will be conducted tentatively on **08th July 2025 (11.00 a.m. to 12.00 noon).**

c) The syllabus for written test is given in the appendix I.

d) Written test comprises of 50 multiple choice questions for 50 marks.

e) The question paper pattern comprises of 20 marks from general skills (English and Mathematics) and 30 marks from Technical skills (Respective discipline).

f) The candidates appeared for the written test need to appear for a personal interview by the Departmental Research Committee comprising HOD and all eligible guides.

g) During the interview, the candidates shall present their research area/concept.

4. ADMISSION PROCEDURE

a) Admission will be made as per the reservation policy of the Government of India.

b) Candidates whose selection is approved by the Director will be admitted to the Ph.D. programme after paying the prescribed fees and verification of all the certificates. The candidate should also pay fees every semester as prescribed by the institute failing which registration will be cancelled automatically.

c) After the selection of candidates for the Ph.D. programme, the allocation of supervisors will be carried out by a committee comprising the Director and Heads of the respective Departments, based on the availability of vacancies under eligible supervisors.

5. FEE STRUCTURE

Particulars	Amount (INR)
A. ONE TIME FEES	
Admission Fee	2,400
Certificate / Thesis Fee	12,000
Student Welfare Fee	2,400
Infrastructure Development Fee	3,600
Alumni Life Membership Fee	1,200
Total (A)	**21,600**
B. SEMESTER FEES	
Tuition Fee	14,400
Registration	1,200
Medical Fees	3,600
Library Fee	2,400
Total (B)	**21,600**
TOTAL [A+B]	**43,200**

6. APPLICATION PROCEDURE

Candidates applying for Ph.D. programme can apply through the online portal available at www.iiitt.ac.in. A non-refundable application fee of Rs. 1000/- (Rs.500/- for SC/ST/Divyang) has to be paid to the institute account whose details are given below:

Name of the Account: Indian Institute of Information Technology Tiruchirappalli

Name of the Bank: Punjab National Bank, Sethurapatti, Tiruchirappalli

Account Number: 1088000106101545

IFSC: PUNB0108800

Once the payment is completed, kindly note the transaction number. It has to be mentioned in the online application.

If you are applying for more than one department / mode, submit a separate application for each department /mode.

Note: The candidates are advised to check the IIITT website frequently for regular updates. The shortlisted candidates will be announced only on IIITT website. No other communication will be sent regarding the Ph.D admission process.

Steps to apply for online application

1. Pay the application fee.

   Note: **Candidates applying for more than one department should submit separate application form for each department / mode**.
2. Read the instructions carefully before filling the application.
3. Scan the Recent color passport size photo and signature with file size less than 3MB.
4. Scan the supporting documents as listed below in a single PDF file in the same sequence
    - Fee Details proof
    - OBC / SC / ST and PH Certificate (if applicable)
    - UG Consolidated Marksheet
    - PG Consolidated Marksheet
    - UG Degree Certificate
    - PG Degree Certificate / Provisional Certificate
    - Research Proposal (Max 500 words)
    - GATE / UGC / NET / CSIR / SLET score card (if applicable)
    - HSC Marksheet
    - SSLC Marksheet
    - No Objection Certificate (if applicable)
    - Experience Certificate (if applicable)
    - Journal publications (First page alone)
    - Aadhar card
5. After **Final Submit,** you cannot edit the application.
6. The end date is **June 27th, 2025 at 5:00 pm**. Applicants are strongly advised to complete and submit their applications well ahead of the deadline. The Institute will not be responsible for any last-minute problems such as poor internet connectivity.
7. Applications which are not duly filled in and are not having supporting documents will be summarily **REJECTED.**
8. The Institute reserves the right to fill up or not to fill up the candidates in any stream.

7. IMPORTANT DATES:

Start date of Online Application	**28/05/2025**
Last Date of filling up Online Application and time	**27/06/2025, & 5 PM**
Scrutiny of the applications	**01/07/2025**
Announcement of shortlisted candidates list for Written test	**04/07/2025***
Written test & Interview	**08/07/2025* & 09/07/2025***
Provisionally selected candidates list	**11/07/2025***
Last date for fee payment	**25/07/2025***
Course registration	**26/07/2025**
Commencement of course work	**28/07/2025**

*Tentative

Appendix I

Syllabus for Ph.D. Written Test

COMPUTER SCIENCE AND ENGINEERING (CSE)

Digital Logic

Boolean algebra. Combinational and sequential circuits. Minimization. Number representations and computer arithmetic (fixed and floating point).

Computer Organization and Architecture

Machine instructions and addressing modes. ALU, data-path and control unit. Instruction pipelining, pipeline hazards. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).

Programming and Data Structures

Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

Algorithms

Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide-and-conquer. Graph traversals, minimum spanning trees, shortest paths

Theory of Computation

Regular expressions and finite automata. Context free grammars and push down automata. Regular and contex free languages, pumping lemma. Turing machines and undecidability.

Compiler Design

Lexical analysis, parsing, syntax directed translation. Runtime environments. Intermediate code generation. Local optimisation, Data flow analyses: constant propag ation, liveness analysis, common subexpression elimination.

Operating System

System calls, processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU and I/O scheduling. Memory management and virtual memory. File systems.

Databases

ER-model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.

Computer Networks

Concept of layering: OSI and TCP/IP Protocol Stacks; Basics of packet, circuit and virtual circuit switching; Data link layer: framing, error detection, Medium Access Control, Ethernet bridging; Routing protocols: shortest path, flooding, distance vector and link state routing; Fragm entation and IP addressing, IPv4, CIDR notation, Basics of IP support protocols (ARP, DHCP, ICMP), Network Address Translation (NAT); Transport layer: flow control and congestion control, UDP, TCP, sockets; Application layer protocols: DNS, SMTP, HTTP, FTP.

ELECTRONICS AND COMMUNICATION ENGINEERING (ECE)

Section 1: Engineering Mathematics

Linear Algebra: Vector space, basis, linear dependence and independence, matrix algebra, eigenvalues and eigenvectors, rank, solution of linear equations- existence and uniqueness.

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

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

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

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

Probability and Statistics: Mean, median, mode, standard deviation, combinatorial probability, probability distributions, binomial distribution, Poisson distribution, exponential distribution, normal distribution, joint and conditional probability.

Section 2: Networks, Signals and Systems

Circuit analysis: Node and mesh analysis, superposition, Thevenin's theorem, Norton's theorem, reciprocity.

Sinusoidal steady state analysis: phasors, complex power, maximum power transfer.

Time and frequency domain analysis of linear circuits: RL, RC and RLC circuits, solution of network equations using Laplace transform.

Linear 2-port network parameters, wye-delta transformation.

Continuous-time signals: Fourier series and Fourier transform, sampling theorem and applications.

Discrete-time signals: DTFT, DFT, z-transform, discrete-time processing of continuous-time signals. LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeroes, frequency response, group delay, phase delay.

Section 3: Electronic Devices

Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors.

Carrier transport: diffusion current, drift current, mobility and resistivity, generation and recombination of carriers, Poisson and continuity equations.

P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell.

Section 4: Analog Circuits

Diode circuits: clipping, clamping and rectifiers.

BJT and MOSFET amplifiers: biasing, ac coupling, small signal analysis, frequency response.

Current mirrors and differential amplifiers.

Op-amp circuits: Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers and oscillators.

Section 5: Digital Circuits

Number representations: binary, integer and floating-point- numbers.

Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders.

Sequential circuits: latches and flip-flops, counters, shift-registers, finite state machines, propagation delay, setup and hold time, critical path delay.

Data converters: sample and hold circuits, ADCs and DACs.

Semiconductor memories: ROM, SRAM, DRAM.

Computer organization: Machine instructions and addressing modes, ALU, data-path and control unit, instruction pipelining.

Section 6: Control Systems

Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

Section 7: Communications

Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems.

Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, superheterodyne receivers.

Information theory: entropy, mutual information and channel capacity theorem.

Digital communications: PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, MAP, ML detection, matched filter receiver, SNR and BER.

Fundamentals of error correction, Hamming codes, CRC.

Section 8: Electromagnetics

Maxwell's equations: differential and integral forms and their interpretation, boundary conditions,wave equation, Poynting vector.

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

Transmission lines: equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart.

Rectangular and circular waveguides, light propagation in optical fibers, dipole and monopole antennas, linear antenna arrays.

ENGLISH

NOTE: The units may also be tested through comprehension passages to assess critical reading, critical thinking and writing skills.

Unit I - Drama

Unit II - Poetry

Unit III - Fiction, Short Story

Unit IV - Non-Fiction (Prose)

Unit V - Language: Basic concepts, theories and pedagogy

Unit VI - English in India: history, evolution and futures

Unit VII – Cultural Studies

Unit VIII - Literary Criticism

Unit IX – Literary Theory Post World War II

Unit X - Research Methods and Materials in English

MATHEMATICS

Calculus: Functions of two or more variables, continuity, directional derivatives, partial derivatives, total derivative, maxima and minima, saddle point, method of Lagrange's multipliers; Double and Triple integrals and their applications to area, volume and surface area; Vector Calculus: gradient, divergence and curl, Line integrals and Surface integrals, Green's theorem, Stokes' theorem, and Gauss divergence theorem.

Linear Algebra: Finite dimensional vector spaces over real or complex fields; Linear transformations and their matrix representations, rank and nullity; systems of linear equations, characteristic polynomial, eigenvalues and eigenvectors, diagonalization, minimal polynomial, Cayley-Hamilton Theorem, Finite dimensional inner product spaces, Gram-Schmidt orthonormalization process, symmetric, skew-symmetric, Hermitian, skew-Hermitian, normal, orthogonal and unitary matrices; diagonalization by a unitary matrix, Jordan canonical form; bilinear and quadratic forms.

Real Analysis: Metric spaces, connectedness, compactness, completeness; Sequences and series of functions, uniform convergence, Ascoli-Arzela theorem; Weierstrass approximation theorem; contraction mapping principle, Power series; Differentiation of functions of several variables, Inverse and Implicit function theorems; Lebesgue measure on the real line, measurable functions; Lebesgue integral, Fatou's lemma, monotone convergence theorem, dominated convergence theorem.

Complex Analysis: Functions of a complex variable: continuity, differentiability, analytic functions, harmonic functions; Complex integration: Cauchy's integral theorem and formula; Liouville's theorem, maximum modulus principle, Morera's theorem; zeros and singularities; Power series, radius of convergence, Taylor's series and Laurent's series; Residue theorem and applications for evaluating real integrals; Rouche's theorem, Argument principle, Schwarz lemma; Conformal mappings, Mobius transformations.

Ordinary Differential equations: First order ordinary differential equations, existence and uniqueness theorems for initial value problems, linear ordinary differential equations of higher order with constant coefficients; Second order linear ordinary differential equations with variable coefficients; Cauchy-Euler equation, method of Laplace transforms for solving ordinary differential equations, series solutions (power series, Frobenius method); Legendre and Bessel functions and their orthogonal properties; Systems of linear first order ordinary differential equations, Sturm's oscillation and separation theorems, Sturm-Liouville eigenvalue problems, Planar autonomous systems of ordinary differential equations: Stability of stationary points for linear systems with constant coefficients, Linearized stability, Lyapunov functions.

Algebra: Groups, subgroups, normal subgroups, quotient groups, homomorphisms, automorphisms; cyclic groups, permutation groups, Group action, Sylow's theorems and their

applications; Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domains, Principle ideal domains, Euclidean domains, polynomial rings, Eisenstein's irreducibility criterion; Fields, finite fields, field extensions, algebraic extensions, algebraically closed fields.

Functional Analysis: Normed linear spaces, Banach spaces, Hahn-Banach theorem, open mapping and closed graph theorems, principle of uniform boundedness; Inner-product spaces, Hilbert spaces, orthonormal bases, projection theorem, Riesz representation theorem, spectral theorem for compact self-adjoint operators.

Numerical Analysis: Systems of linear equations: Direct methods (Gaussian elimination, LU decomposition, Cholesky factorization), Iterative methods (Gauss-Seidel and Jacobi) and their

convergence for diagonally dominant coefficient matrices; Numerical solutions of nonlinear equations: bisection method, secant method, Newton-Raphson method, fixed point iteration; Interpolation: Lagrange and Newton forms of interpolating polynomial, Error in polynomial interpolation of a function; Numerical differentiation and error, Numerical integration: Trapezoidal and Simpson rules, Newton-Cotes integration formulas, composite rules, mathematical errors involved in numerical integration formulae; Numerical solution of initial value problems for ordinary differential equations: Methods of Euler, Runge-Kutta method of order 2.

Partial Differential Equations: Method of characteristics for first order linear and quasilinear partial differential equations; Second order partial differential equations in two independent variables: classification and canonical forms, method of separation of variables for Laplace equation in Cartesian and polar coordinates, heat and wave equations in one space variable; Wave equation: Cauchy problem and d'Alembert formula, domains of dependence and influence, non-homogeneous wave equation; Heat equation: Cauchy problem; Laplace and Fourier transform methods.

Topology: Basic concepts of topology, bases, subbases, subspace topology, order topology, product topology, quotient topology, metric topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma.

Linear Programming: Linear programming models, convex sets, extreme points; Basic feasible solution, graphical method, simplex method, two phase methods, revised simplex method; Infeasible and unbounded linear programming models, alternate optima; Duality theory, weak duality and strong duality; Balanced and unbalanced transportation problems, Initial basic feasible solution of balanced transportation problems (least cost method, north-west corner rule, Vogel's approximation method); Optimal solution, modified distribution method; Solving assignment problems, Hungarian method.

PHYSICS

Section 1: Mathematical Physics

Vector calculus: linear vector space: basis, orthogonality and completeness; matrices; similarity transformations, diagonalization, eigenvalues and eigenvectors; linear differential equations: second order linear differential equations and solutions involving special functions; complex analysis: Cauchy-Riemann conditions, Cauchy's theorem, singularities, residue theorem and applications; Laplace transform, Fourier analysis; elementary ideas about tensors: covariant and contravariant tensors.

Section 2: Classical Mechanics

Lagrangian formulation: D'Alembert's principle, Euler-Lagrange equation, Hamilton's principle, calculus of variations; symmetry and conservation laws; central force motion: Kepler problem and Rutherford scattering; small oscillations: coupled oscillations and normal modes; rigid body dynamics: interia tensor, orthogonal transformations, Euler angles, Torque free motion of a symmetric top; Hamiltonian and Hamilton's equations of motion; Liouville's theorem; canonical transformations: action-angle variables, Poisson brackets, Hamilton Jacobi equation.

Special theory of relativity: Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Section 3: Electromagnetic Theory

Solutions of electrostatic and magnetostatic problems including boundary value problems; method of images; separation of variables; dielectrics and conductors; magnetic materials; multipole expansion; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; electromagnetic waves in free space, non conducting and conducting media; reflection and transmission at normal and oblique incidences; polarization of electromagnetic waves; Poynting vector, Poynting theorem, energy and momentum of electromagnetic waves; radiation from a moving charge.

Section 4: Quantum Mechanics

Postulates of quantum mechanics; uncertainty principle; Schrodinger equation; Dirac Bra-Ket notation, linear vectors and operators in Hilbert space; one dimensional potentials: step potential, finite rectangular well, tunneling from a potential barrier, particle in a box, harmonic oscillator; two and three dimensional systems: concept of degeneracy; hydrogen atom; angular momentum and spin; addition of angular momenta; variational method and WKB approximation, time independent perturbation theory; elementary scattering theory, Born approximation; symmetries in quantum mechanical systems.

Section 5: Thermodynamics and Statistical Physics

Laws of thermodynamics; macrostates and microstates; phase space; ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, phase equilibria, critical point.

Section 6: Atomic and Molecular Physics

Spectra of one-and many-electron atoms; spin-orbit interaction: LS and jj couplings; fine and hyperfine structures; Zeeman and Stark effects; electric dipole transitions and selection rules; rotational and vibrational spectra of diatomic molecules; electronic transitions in diatomic

molecules, Franck-Condon principle; Raman effect; EPR, NMR, ESR, X-ray spectra; lasers: Einstein coefficients, population inversion, two and three level systems.

Section 7: Solid-State Physics

Elements of crystallography; diffraction methods for structure determination; bonding in solids; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids: nearly free electron and tight binding models; metals, semiconductors and insulators; conductivity, mobility and effective mass; Optical properties of solids; Kramer's-Kronig relation, intra- and inter-band transitions; dielectric properties of solid; dielectric function, polarizability, ferroelectricity; magnetic properties of solids; dia, para, ferro, antiferro and ferri-magnetism, domains and magnetic anisotropy; superconductivity: Type-I and Type II superconductors, Meissner effect, London equation, BCS Theory, flux quantization.

Section 8: Electronics

Semiconductors in equilibrium: electron and hole statistics in intrinsic and extrinsic semiconductors; metal-semiconductor junctions; Ohmic and rectifying contacts; PN diodes, bipolar junction transistors, field effect transistors; negative and positive feedback circuits; oscillators, operational amplifiers, active filters; basics of digital logic circuits, combinational and sequential circuits, flip-flops, timers, counters, registers, A/D and D/A conversion.

Section 9: Nuclear and Particle Physics

Nuclear radii and charge distributions, nuclear binding energy, electric and magnetic moments; semi-empirical mass formula; nuclear models; liquid drop model, nuclear shell model; nuclear force and two nucleon problem; alpha decay, beta-decay, electromagnetic transitions in nuclei; Rutherford scattering, nuclear reactions, conservation laws; fission and fusion; particle accelerators and detectors; elementary particles; photons, baryons, mesons and leptons; quark model; conservation laws, isospin symmetry, charge conjugation, parity and time-reversal invariance

Mechanical Engineering

Section 1: Engineering Mathematics

Linear Algebra: Matrix algebra, systems of linear equations, eigenvalues and eigenvectors.

Calculus: Functions of single variable, limit, continuity and differentiability, mean value theorems, indeterminate forms; evaluation of definite and improper integrals; double and triple integrals; partial derivatives, total derivative, Taylor series (in one and two variables), maxima and minima, Fourier series; gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, applications of Gauss, Stokes and Green's theorems.

Differential Equations: First order equations (linear and nonlinear); higher order linear differential equations with constant coefficients; Euler-Cauchy equation; initial and boundary value problems; Laplace transforms; solutions of heat, wave and Laplace's equations.

Complex Variables: Analytic functions; Cauchy-Riemann equations; Cauchy's integral theorem and integral formula; Taylor and Laurent series.

Probability and Statistics: Definitions of probability, sampling theorems, conditional probability; mean, median, mode and standard deviation; random variables, binomial, Poisson and normal distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations; integration by trapezoidal and Simpson's rules; single and multi-step methods for differential equations.

Section 2: Applied Mechanics and Design

Engineering Mechanics: Free-body diagrams and equilibrium; friction and its applications including rolling friction, belt-pulley, brakes, clutches, screw jack, wedge, vehicles, etc.; trusses and frames; virtual work; kinematics and dynamics of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations; Lagrange's equation.

Mechanics 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; concept of shear centre; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.

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

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

Section 3: Fluid Mechanics and Thermal Sciences

Fluid Mechanics: Fluid properties; fluid statics, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings; basics of compressible fluid flow.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan-Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behavior of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

Applications: Power Engineering: Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes. Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines; steam and gas turbines.

Section 4: Materials, Manufacturing and Industrial Engineering

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

Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding.

Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, jigs and fixtures; abrasive machining processes; NC/CNC machines and CNC programming.

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly; concepts of coordinate-measuring machine (CMM).

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools; additive manufacturing.

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

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

Operations Research: Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.