



**Centre for Advanced Studies**  
(Dr. APJ Abdul Kalam Technical University, Uttar Pradesh, Lucknow)

**Ph.D. Entrance Test- 2019-20 (Phase-I)**

**Schedule of PhD entrance examination**

S No.	PhD Course	Date	Time	Venue
1	Computer Science & Engineering	09.08.2019 (Friday)	11:00 AM-1:00 PM	Centre for Advanced Studies, Dr. APJ Abdul Kalam Technical University Uttar Pradesh, Sector-11, Jankipuram Extension, Lucknow-226031
2	Mechatronics	09.08.2019 (Friday)	11:00 AM -1:00 PM	
3	Nanotechnology	09.08.2019 (Friday)	2:00 to 4:00 PM	

**Important Instructions to the Candidates**

1. Candidate's signature should tally with the signature uploaded at the time of filling online application form. In case of discrepancy, candidate will not be allowed for appearing in the exam.
2. Candidate must carry his/her **Admit card** along with any Identity Authentication document (Identity card issued by Government agency such as Aadhaar card, Pan card, Driving licence, Voter id card etc.), failing which entry in the Examination Centre/Hall shall not be allowed.
3. Candidates are advised to report at the centre at least 45 minutes before the commencement of the examination.
4. Candidates must affix recent passport size photograph matching with the one uploaded in the online application, on the space provided under self-attestation before entering in the exam hall.
5. Candidates should use only Blue/Black Ball Point Pen for filling up the particulars on Test Booklet, OMR Sheet and Attendance sheet for the exam. Use of pencil/Gel pen is strictly prohibited and not permitted in any case.
6. Candidates should go through the instructions given on the Test Booklet carefully.
7. Candidates should sit only on the allotted seats. Candidates must see their details on the Desk Slip before occupying the seat. The seats allotted to candidates who are absent should be left vacant.
8. Candidates are not allowed to carry any text material, printed or written, piece of paper, slide rules, log tables, pager, mobile phones, programmable or non-programmable calculators and other electronic devices except the Admit Card, Black/Blue Pen inside the examination hall/room. Frisking of candidates will be done at the entry point of the Examination Centre.
9. **The question paper will have 100 objective questions of equal marks. 80 questions would be from subject domain and 20 questions would be from research methodology area.**

10. There would be **NEGATIVE** marking. Each correct answer will get 3 marks while for each wrong answer **ONE mark would be deducted.**
11. Impersonation, obliteration of OMR answer sheet/ Test booklet, use of unfair means shall lead to cancellation of the candidature over & above other suitable action(s) against the candidate.
12. Candidates found copying or resorting to any unfair means including giving/receiving help to /from any candidate during the test or violating any conditions of test will be summarily disqualified. Such candidates will also forfeit all claims for admission in the Institute in future.
13. Candidates may approach the Centre Superintendent in case of any difficulty and should abide by his/her instructions and decisions. Complaints, if any, regarding the examination should be given in writing to the centre Superintendent of the centre.
14. Candidates will not be allowed to leave the examination hall before the closure of the test.

**NOTE: THIS ADMIT CARD MUST BE RETAINED BY THE CANDIDATES TILL ADMISSION PROCESS IS OVER. IT WILL BE REQUIRED AT THE TIME OF COUNSELLING/INTERVIEW.**

## **SYLLABUS for Ph.D Entrance Examination (2019-20)**

**Technical domain knowledge (80 questions)**

**Research methodology knowledge (20 questions)**

### **1. Computer Science & Engineering**

#### **Section 1: Engineering Mathematics**

Discrete Mathematics: Propositional and first order logic. Sets, relations, functions, partial orders and lattices. Groups. Graphs: connectivity, matching, coloring. Combinatorics: counting, recurrence relations, generating functions.

Linear Algebra: Matrices, determinants, system of linear equations, eigenvalues and eigenvectors, LU decomposition.

Calculus: Limits, continuity and differentiability. Maxima and minima. Mean value theorem. Integration.

Probability: Random variables. Uniform, normal, exponential, poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.

Computer Science and Information Technology

#### **Section 2: Digital Logic**

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

#### **Section 3: Computer Organization and Architecture**

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

## Section 4: Programming and Data Structures

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

## Section 5: Algorithms

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

## Section 6: Theory of Computation

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

## Section 7: Compiler Design

Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation.

## Section 8: Operating System

Processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU scheduling. Memory management and virtual memory. File systems.

## Section 9: Databases

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

## Section 10: Computer Networks

Concept of layering. LAN technologies (Ethernet). Flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state). TCP/UDP and sockets, congestion control. Application layer protocols (DNS, SMTP, POP, FTP, HTTP). Basics of Wi-Fi.

Network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls.

## 2. NANOTECHNOLOGY

**General aptitude in RM (Research Methodology) and fundamentals/basics: in/of Nano Science and Nanotechnology as well as in/of the following topics.**

**Quantum Physics:** Basis of Quantum Physics, de Broglie's concept, operators, physical interpretation of wave function, normalised and orthogonal wave function, Heisenberg's uncertainty Principle.

**Solid State Physics:** Crystal structure, Bravais lattices and its basics, Miller indices, X-ray diffraction and Bragg's law, free electron theory of metals. Fermi energy and density of states, origin of energy bands, concept of holes and effective mass. Energy levels in One Dimension, Fermi-

Dirac distribution, effect of Temperature on the Fermi-Dirac Distribution, free electron gas in three-dimension, crystal imperfections: Point imperfections - vacancy, substitution and interstitial impurity.

**Applied Chemistry:** Structure of solids, symmetry concepts, crystal structure. Preparative methods and characterization of inorganic solids. Crystal defects and non-stoichiometry. Interpretation of phase diagrams, phase transitions. Kinetics of phase transformations, structure property correlations in ceramics, glasses, polymers. Composites and nanomaterials. Basic concepts in biomaterials science, concept and assessment of biocompatibility of biomaterials, examples of some important metallic biomaterials, bio-ceramics and bio-composites

**Electricity and Magnetism:** Coulomb's law, Gauss's law. Electric field and potential. Electrostatic boundary conditions, conductors, capacitors, dielectrics, dielectric polarization, volume and surface charges, electrostatic energy. Biot-Savart law, Ampere's law, Faraday's law of electromagnetic induction Maxwell's equations and static and time varying equations, Poynting's theorem, Lorentz Force and motion of charged particles in electric and magnetic fields, Clausius-Mossotti relation. Fundamentals about dia-, para- and ferromagnetism, Langevin's theory of Para magnetism, Curie's law.

**Materials and their properties:** Different types of materials: Metals, Semiconductors, Composite materials, Ceramics, Alloys, Polymers. Chemical Bonding-Atomic Bonding in solids, Types of bond: Metallic, Ionic, Covalent and van der Waals bond; Hybridisation; Molecular orbital theory; Electrochemistry fundamentals

o *Mechanical Properties:* Stress-strain response of metallic, ceramic and polymer materials, yield strength, tensile strength and modulus of elasticity, toughness, plastic deformation, fatigue, creep and fracture,

o *Electronic Properties:* Free electron theory, Fermi energy, density of states, elements of band theory, semiconductors, Hall effect, dielectric behaviour, piezo, ferro, pyroelectric materials,

o *Magnetic Properties:* Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, ferro and ferrimagnetism,

o *Thermal Properties:* Specific heat, thermal conductivity and thermal expansion, thermoelectricity,

o *Optical Properties:* Refractive index, absorption and transmission of electromagnetic radiation in solids, electrooptic and magneto-optic materials, spontaneous and stimulated emission, gas and solid-state lasers

**Fabrication:** Nanoparticles Synthesis-Carbon Nanotubes, Metal nanoparticles, Q-Dots, Nanowires Thin films synthesis-Chemical Vapor Deposition, Physical Vapor Deposition, Self-Assembly, Lithography-Optical & Electron Lithography, Resists.

**Characterisation:** Electron microscopes, scanning electron microscopes, transmission electron microscope, scanning probe microscopy, atomic force microscopy, scanning tunnelling microscope, Spectroscopy- FTIR, UV-Vis, Raman.

**Electronics:** Intrinsic and extrinsic Semiconductors. Fermi level. p-n junctions, transistors, semiconductor; diodes; solar cell fundamentals

### 3. MECHATRONICS

**Engineering Mechanics:**Free-body diagrams and equilibrium; trusses and frames; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular), collisions.

**Machine Design:**Design for static and dynamic loading; failure theories; fatigue strength and the 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,Cams, gears and gear trains

**Heat-Transfer:**Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; heat transfer correlations for flow over flat plates and through pipes.

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

**Joining Processes:**Principles of welding, brazing, soldering and adhesive bonding.

**Metrology and Inspection:**Limits, fits and tolerances; linear and angular measurements; comparators.

#### **Basic Electronics:**

Conductors, insulators, semi-conductors, Passive components used in Electronics, Transformers, semi-conductors, Transistors, Silicon controlled rectifiers (SCR), Integrated Circuits (IC), Digital Circuits. Diodes, Electrical Elements, Energy bands in intrinsic and extrinsic, mobility and resistivity; P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell.

#### **Electrical and Mechanical Actuators:**

Drives, Spindle drives, feed drives, AC and DC motors, Stepper motors, Servo motors, Servo-principle, Drive protection, Pascal Law, Pneumatic and hydraulic actuators etc.

**Sensors and Transducers:** Potentiometer, Variable-Inductance Transducer, Variable-Capacitance Transducers, Piezoelectric Sensors, Strain Gauges, Torque sensors, Tactile sensing, Ultra sonic sensors, Thermo fluid sensors, Digital transducers.

#### **Digital Hardware and Microcontrollers:**

Number systems and codes, Microcontrollers: Architecture, microprocessor, memory,

#### **Control Systems**

Basic control system components; Feedback principle; Transfer function; Block diagram representation, stability, Fuzzy logic control, digital control.