Syllabus for Screening Test for Ph.D. Admissions 2019-20

1. Department of Civil Engineering

Engineering Mechanics, Solid Mechanics, Structural Analysis, Construction Materials & Management, Concrete Structure, Steel Structure, Soil Mechanics, Foundation Engineering, Fluid Mechanics, Hydraulics, Hydrology, Irrigation, Transportation Engineering, Geomatics Engineering

2. Department of Electrical Engineering

Section 1: Electric Circuits

Network graph, KCL, KVL, Node and Mesh analysis, Transient response of dc and ac networks, Sinusoidal steady-state analysis, Resonance, Passive filters, Ideal current and voltage sources, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Two-port networks, Three phase circuits, Power and power factor in ac circuits.

Section 2: Electromagnetic Fields

Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence,Electric field and potential due to point, line, plane and spherical charge distributions,Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law,Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force,Reluctance, Magnetic circuits,Self and Mutual inductance of simple configurations.

Section 3: 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, Applications of Fourier Transform, Laplace Transform and z-Transform.

Section 4: Electrical Machines

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, parallel operation;Auto-transformer, Electromechanical energy conversion principles, DC machines:separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load

and blocked rotor tests, equivalent circuit, starting and speed control; Operating principle of single phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance, regulation and parallel operation of generators, starting of synchronous motor, characteristics; Types of losses and efficiency calculations of electric machines.

Section 5: Power Systems

Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss-Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

Section 6: Control Systems

Mathematical modeling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, State transition matrix.

Section 7: Electrical and Electronic Measurements

Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multimeters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.

Section 8: Analog and Digital Electronics

Characteristics of diodes, BJT, MOSFET; Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: Biasing, Equivalent circuit and Frequency response; Operational amplifiers: Characteristics and applications; Combinational and Sequential logic circuits, Multiplexer, Demultiplexer,8085Microprocessor: Architecture, Programming and Interfacing.

Section 9: Power Electronics

Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET,IGBT; DC to DC conversion: Buck, Boost and Buck-Boost converters; Single and three phase configuration of uncontrolled rectifiers, Line commutated thyristor based converters, Bidirectional ac to dc voltage source converters, Issues of line current harmonics, Power factor, Distortion factor of ac to dc converters, Single phase and three phase inverters, Sinusoidal pulse width modulation.

3. **Department of Environmental Engineering**

Characteristics of water and waste water, Water quality requirements, Water & waste water treatment, Air quality, Air Pollution & control, Solid waste, Solid waste management, Engineering system for resource and energy recovery, Industrial waste management, Environmental impact assessment

4. **Department of Delhi School of Management / USME**

Managerial themes such as E-Governance, Information Technology Management, Strategic Management, Marketing Management, Distribution and Retail Management, Organizational Behavior, Human Resource Management, Corporate Governance and Ethics, Public Policy and Governance, Accounting and Finance, Portfolio Management, Mergers and Acquisition, Corporate Restructuring, Knowledge Management, General Management Principle and Practices, Supply Chain Management, Business Research Methods, Business Statistics.

5. **Department of Applied Physics**

- Classical Mechanics
- Quantum Mechanics
- Statistical Mechanics
- Mathematical Physics
- Solid State Physics
- Nuclear Physics
- Electrodynamics
- Optics
- Fiber Optics
- Atomic and Molecular Physics
- Materials Science
- Thermodynamics
- Basic Electronics
- Numerical Techniques

6. Department of Applied Chemistry

- Organic Chemistry: Name Reactions; Reaction Mechanism; Stereochemistry of Carbon Compounds
- Inorganic Chemistry: Co-ordination Chemistry; Organometallic Chemistry
- Physical Chemistry; Chemical Equilibrium; Catalysis; Electrochemistry
- Characterization Techniques: NMR; IR, UV; Mass Spectrometry; DSC; TGA; DMA; SEM; TEM; GPC
- Plastic and Rubber Technology: Polyethylene; Polypropylene; Polyurethane; Acrylics; PET; Polycarbonates; Natural Rubber, SBR; Butadiene; Nitrile Rubber
- Polymer Processing: Additives for polymers; Compounding; Polymer processing techniques.
- Polymer Chemistry: Addition Polymerization; Condensation Polymerization; Ring Opening Polymerization
- Basic Chemical Engineering: Material and Energy Balance, Unit Operations in Chemical Engineering. Modes of Heat Transfer.
- Chemical Reaction and Kinetics: Kinetics of Homogeneous Reactions, Arrhenius Law, Interpretation of batch reactor data: Constant and variable volume batch reactor, Differential and Integral method of data analysis.
- Thermodynamics and Fluid Mechanics: Laws of Thermodynamics, Phase rule, Work and Energy, Principles governing Fluid flow, Newtonian and Non-Newtonian Fluids, Laminar and Turbulent flows.

7. Department of Biotechnology

1. Molecules and their Interaction Relevant to Biology
2. Cellular Organization
3. Fundamental Processes
4. Cell Communication and Cell Signaling
5. Developmental Biology
6. Plant and Animal Biotechnology
8. Inheritance Biology
9. Diversity of Life Forms and Environmental Biology
10. Ecological Principles
11. Evolution and Behaviour
12. Applied Biology and Assay Techniques in Biology
13. Immunology and Immunotechnology
14. Computational Biology
15. Diagnostic Techniques

8. Department of Applied Mathematics

- Differential & Integral calculus Vector calculus
- Algebra (Linear & Abstract)
- Differential equations (ODE & PDE)
- Laplace & Fourier transforms, Fourier series.
- Probability, statistics & operations research
- Numerical methods
- Special functions
- Real and complex analysis

Networks, Signals and Systems

Network solution methods: nodal and mesh analysis; Network theorems: superposition, Thevenin and Norton's, maximum power transfer; Wye□Delta transformation; Steady state sinusoidal analysis using phasors; Time domain analysis of simple linear circuits; Solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits; Linear 2□port network parameters: driving point and transfer functions; State equations for networks.
Continuous-time signals: Fourier series and Fourier transform representations, sampling theorem and applications; Discrete-time signals: discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform, interpolation of discrete-time signals; LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay, digital filter design techniques.

Electronic Devices

Energy bands in intrinsic and extrinsic silicon; 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; Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography and twin-tub CMOS process.

Analog Electronics

Small signal equivalent circuits of diodes, BJTs and MOSFETs; Simple diode circuits: clipping, clamping and rectifiers; Single-stage BJT and MOSFET amplifiers: biasing, bias stability, mid-frequency small signal analysis and frequency response; BJT and MOSFET amplifiers: multi-stage, differential, feedback, power and operational; Simple op-amp circuits; Active filters; Sinusoidal oscillators: criterion for oscillation, single-transistor and op-amp configurations; Function generators, wave-shaping circuits and 555 timers; Voltage reference circuits; Power supplies: ripple removal and regulation

Digital Circuits

Number systems; 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 and PLAs; Sequential circuits: latches and flip□flops, counters, shift□registers and finite state machines; Data converters: sample and hold circuits, ADCs and DACs; Semiconductor memories: ROM, SRAM, DRAM; 8-bit microprocessor (8085): architecture, programming, memory and I/O interfacing.

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.

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, circuits for analog communications; Information theory: entropy, mutual information and channel capacity theorem; Digital communications: PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter receiver, calculation of bandwidth, SNR and BER for digital modulation; Fundamentals of error correction, Hamming codes; Timing and frequency synchronization, inter-symbol interference and its mitigation; Basics of TDMA, FDMA and CDMA.

Electromagnetics

Electrostatics; 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; Waveguides: modes, boundary conditions, cut-off frequencies, dispersion relations; Antennas: antenna types, radiation pattern, gain and directivity, return loss, antenna arrays; Basics of radar; Light propagation in optical fibers

10. Department of Design

1. Visualization and Spatial ability
2. Environmental and Social awareness
3. Analytical and logical reasoning
4. Language and creativity
5. Observation and Design Sensitivity

1. **Computing related Mathematics:** Propositional and first order logic. Sets, relations, functions, partial orders and lattices. Groups. Vectors, Matrices, determinants, system of linear equations, eigenvalues and eigenvectors, LU decomposition. Vector space, Differential equations, Gradients, Maxima, Minima, Random variables. Uniform, Gaussian, exponential, Poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.
2. **Programming and Data Structures:** Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.
3. **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.
4. **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.
5. **Compiler Design:** Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation.
6. **Operating System:** Processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU scheduling. Memory management and virtual memory. File systems.
7. **Databases Management Systems:** 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.
8. **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.
9. **Software Engineering:** Software development life cycle, Requirement and feasibility analysis, data flow diagrams process specifications, input/output design, planning and managing the project, design, coding, Software testing, implementation, maintenance, software metrics.
10. **Web Technologies:** HTML, XML, JavaScript, basic concepts of client-server computing, HTTP, Social Web, Search Engine, Web IR retrieval, Web Mining, Big-data.
11. **Artificial Intelligence:** AI approach for solving problems, Automated reasoning for propositional logic and predicate logic, State space representation of problems, bounding functions, breadth first, depth first, A, A*, AO*, etc. Frames, Scripts, semantic nets, production systems, procedural representation.

12. **Department of Mechanical Engineering**

1. THERMODYNAMICS & HEAT POWER ENGINEERING

Thermodynamic Cycles and IC Engines, Laws of thermodynamics and applications. Steam Power Plants, Boilers, Turbines, Compressors, Fans and Blowers,

2. REFRIGERATION AND AIR CONDITIOINING

Different modes of heat transfer. Heat Exchangers, Refrigeration and Heat pump Systems, Vapour absorption Refrigeration Systems, Refrigerants. and Air conditioning systems,

3. FLUID MECHANICS

Viscosity and Its Measurement, Pressure measurement Devices, Flow kinematics, Flow dynamics, Navier-Stokes equation, Bernoulli's theorem, Flow measurements, Laminar and turbulent flows. Boundary Layer Theory, Fluid power machineries.

4. THEORY OF MACHINES

Mechanisms, Governors, cams, gears, gear-trains, Mechanical vibrations, flywheel, balancing.

5. MACHINE DESIGN

Stress at a point, principal stresses, bending, torsion, buckling. Design of joints, shafts, key and Coupling, Brakes, Gears and Gear Box. Piston , Crank Shaft , Connecting Rod

6. ENGINEERING MATERIALS

Structure and properties of common engineering materials. Heat treatment of steels.

7. PRODUCTION ENGINEERING

Metal Forming, Metal casting, Welding, Metal cutting. Machine Tool Design, Mechinability & Economics of Metal Machining Automation and Robotics.

8. INDUSTRIAL ENGINEERING

Production Planning and Control : Forecasting, scheduling; assembly line balancing, PERT and CPM. Control Operations : Inventory control, Work measurement, Quality Management.

13. Department of Humanities (Economics)

Micro Economics

Consumer behavior, Demand and Supply analysis, Concept of Elasticity, Theory of production and costs, Forms of Market, Pricing and Output Decisions, Tax and Subsidy, Elements of General Equilibrium and Welfare Economics.

Micro Economics

Determination of output and Employment, National Income- Concept and Determinants: Concept of money, bank, Inflation- Causes and Remedies, Concept of multiplier, Business Cycle, IS and LM functions. Concept of Growth and Development : Various models of Growth.

International Trade

Theories of International Trade, Balance of Payment, Terms of Trade, Free trade and Protection.

Indian Economy

Main features: Geographic Size, Natural Resources, Population, Poverty, Agriculture, Industry, Unemployment, Public finance, Meaning and Measurement of Growth: Development- meaning and Characteristics of Underdevelopment.

Statistics

Measures of Central tendency, Measures of Dispersion, Correlation, Regression, Interpolation and Extrapolation Sampling distributions- Normal, t, Chi square, F distribution, Testing of hypothesis, Index numbers.

Humanities (English)

1. British Literature from Chaucer to the present day: Age o0f Chaucer, Age of renaissance, Restoration Period, Neo-Classical Age, Romantic Age, Modern Age, Post-Modern Age.
2. Rhetoric and Prosody
3. History of English Language, English Language Teaching.
4. European Literature from classical Age to the 20th century.
5. Literary Theory and Criticism up to T.S. Eliot: Marxist Theory, Feminist Theory, Psychoanalytic Theory, Neo-Historicism, Modernism, Post-Modernism, Structuralism, Post-Structuralism.
6. Indian writing in English and Indian Literature in English translation.
7. American and other non-British English Literatures.