RASHTRASANTTUKADOJIMAHARAJ

NAGPUR UNIVERSITY

Ph. D. Entrance Test

2025-2026

Syllabus of Section A & Section B

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus and Question Paper Pattern for Ph.D Entrance Test (PET)

Section A - Research Methodology and General Aptitude

(As prescribed by the Direction No. 6 of 2021 issued by the Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur)

Maximum Marks: 50 (50 Multiple Choice Questions carrying 1 Mark each)

Maximum Time: 90 Minutes

Research Methodology (40 questions of 1 Mark each)

1. **Meaning and Types of Research:** Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Research and Scientific Method, Criteria of Good Research
2. **Principles of Review of Literature:** Meaning of Literature Review, Importance of Literature Review, Purposes of Literature Review, Sources of Literature Review, Steps in Literature Review, Essentials of a Good Literature Review
3. **Defining a Research Problem:** What is a Research Problem?, Selecting the Problem, Necessity of Defining a Problem, Problem Definition Process, Techniques involved in Defining a Problem
4. **Research Designs:** Meaning of Research Design, Need for Research Design, Features of a Good Research Design, Important Concepts relating to Research Designs, Types of Research Designs, Basic Principles of Experimental Design
5. **Preparing a Research Proposal:** Need for a Research Proposal, Contents of a Research Proposal, Research Proposal as a Planning Tool
6. **Sampling Techniques:** Census and Sample Survey, Implications of a Sample Design, Steps in Sample Designing, Features of a Good Sample Design, Types of Sampling Procedures, Criteria for selecting a Sampling Procedure
7. **Types of Data and Data Collection Techniques:** Significance of Data in Research, Types of Data – Primary and Secondary, Sources of Secondary Data, Methods for collecting Primary Data, Selection of Appropriate Method for Data Collection
8. **Data Analysis Tools:** Significance of Data Analysis, Statistical Tools for Data Analysis – Measures of Central Tendency, Measures of Dispersion, Measures of Relationship, Correlation and Regression Analysis, Other Tools
9. **Referencing Styles:** What is Referencing?, Difference between Referencing and Bibliography, What Needs to be Referenced?, Different Types of Referencing Styles - APA Style, Chicago Manual Style, MLA Style, Sources of References, Elements in a Reference List, Referencing Tools

General Aptitude (10 questions of 1 Mark each)

a. Analytical Reasoning
b. Numerical Ability
c. Data Interpretation
d. Computer Awareness
e. Language Competency

Ph.D- PET Syllabus- Mechanical Engineering
RTMNU. Nagpur

Unit 1: Basic Sciences: Physics, Chemistry, Maths

A. Semiconductor Physics
Introduction, Types of Semiconductor, Current conduction in semiconductors, pn junction diode, Bipolar transistor

B. Elasticity
Introduction, Stress and strain, Elastic constants, Bending of beam, cantilever.

C. Electron optics
Introduction, Motion of charge particles in electric and magnetic field, Electron refraction, Cathode ray tube, Cathode ray oscilloscope.

D. Lubricants: Classification of Lubricants, Mechanism of lubricants, Properties and application.

E. Corrosion: Chemical reactions responsible of Corrosion of Metals, types of corrosion, control measures and design of materials

F. Fuels: Classification of fuels, determination of calorific value, Octane number, cetane number, knocking, alternative energy sources, Bio diesel.

G. Cement: Types of Cement, manufacture of Portland cement.

H. Definition and Properties of Laplace Transform, Inverse Laplace Transforms and its properties, Convolution Theorem (Statement only).

I. Analytic Function, Cauchy-Riemann Conditions, Harmonic Functions, Cauchy Integral Theorem and Integral Formula (Statement only).

J. Partial Differential Equations of First Order First Degree i.e. Lagrange's Form, Linear Homogeneous PDEs of higher order with constant Coefficients.

K. Discrete and Continuous random variables, Probability Function and Distribution Function.

Unit 2: Thermal Engineering

Fluid Mechanics and machinery: Fluid properties; fluid statics, manometry, buoyancy stability of floating bodies; control-volume analysis of mass, momentum and energy; Bernoulli's equation; dimensional analysis; flow through pipes, head losses in pipes, Turbo machinery: Impulse aod reaction principles, Pelton-wheel, Francis and Kaplan turbines, centrifugal and reciprocating pumps.

Thermodynamics: Thermodynamic systems and processes; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of

thermodynamic, thermodynamics cycles. Air compressors; vapour and gas power cycles, I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and air-conditioning basic psychrometric processes.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy dimensionless parameters in free and forced convective heat transfer , heat exchanger radiative heat transfer.

UNIT 3: Design Engineering

Engineering Mechanics: Force system, Lami's theorem, principle of moments, Varignon theorem, couple, Friction: static & dynamic friction, laws of friction, angle of friction, coefficient of friction, Simple machines, Principle of virtual work, projectiles, Law of motion, work, power & energy, Belts & Ropes, Newton's universal law of gravitation.

Strength of Materials: Simple stresses & strain, Principle stresses and strains, Centre of gravity and Moment of inertia, Theorem of perpendicular axes, Bending moments and shearing forces, shearing stresses, deflection of beams, Thin cylindrical shells, thick cylinders, Riveted joints, Torsion of shafts, springs, strain energy, Theories of failure.

Theory of Machines: Simple mechanisms, velocity and acceleration in mechanisms, transmission of power by belts and ropes, Gear transmission, Flywheel, Governors, Balancing of masses, Vibrations, Cams.

Machine Design: Variable stresses in machine parts, Riveted joints, Welded joints, Shafts, Belt, chain and rope drives, Bearings, power screws, shafts and keys, springs, couplings, clutches and brakes, Lubrication

UNIT 4: Production Engineering

Pattern Making & Moulding, Gating System & Casting Processes, Joining Processes, Forming Process for metals, and Introduction to Plastics, Introduction to Machining Parameters, Lathe, Shaper, Slotter, Milling, Grinding operations , Drilling, Non- conventional machining Processes, Advanced machining Processes, Jigs and fixtures , Non Traditional Machining process: Electro-Chemical Machining, Theory of metal cutting, Press working ,Forging die design, Design of jigs and fixtures. Classification, Principle, Sensing elements, Standards of Measurement, Limits and Fits, Tolerance analysis of Limits and Fits, Comparators. Work Study: Productivity, Work measurement, Forecasting: Maintenance, Quality Control, Statistical Quality Control. Introduction to NC, CNC & DNC, Introduction to Group Technology, Introduction to flexible manufacturing systems: Manufacturing Planning: Manufacturing system control, Introduction to MIS, Automation, Industrial Robotics ,AS/RS, Automated inspection & Group technology,

Computer aided manufacturing ,Computer aided process planning ,Fundamentals of Robotics, Robots end-effectors, Robot Kinematics, Robot Sensors,

Unit 5: Interdisciplinary

Measurement and metrology

Measurement fundamentals, Measurement Standards, characteristics of instruments, errors, transducers and measuring instruments for physical measurements.

Mechatronics

What is mechatronics, solid state devices, sensors, SCADA, ADC & DAC conversion, Hydraulic and pneumatic actuators, ladder diagram, PLC structure, PLC applications, logic gates and introduction to microprocessor.

Operation Research

Introduction to OR, linear programming, transportation model, game theory, CPM and PERT.

Industrial Economics and entrepreneurship development & industrial Management

Classification of economics, laws of demand, demand analysis and forecasting, factors of production, break even analysis, inflation and inflation control, product development procedure. Principles of managements, material handling, Elements of Material Handling System, Selection of Material Handling, Study of systems and Equipment's used for Material Storage, plant layout, supply chain management, reengineering and business process management.

Rashtrasanth Tukdoji Maharaj Nagpur University, Nagpur
Board of Civil Engineering
Under
Faculty of Science & Technology

Proposed Syllabus for PHD Entrance Test (PET)

Module 1: Structural Engineering

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations; internal forces in structures; Frictions and its applications.

Solid Mechanics: Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; simple bending theory, flexural and shear stresses, shear center; Uniform torsion, Transformation of stress; buckling of column, combined and direct bending stresses.

Structural Analysis: Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods.

Construction Materials and Management: Construction Materials: Structural Steel – Composition, material properties and behavior; Concrete - Constituents, mix design, short- term and long-term properties. Construction Management: Types of construction projects; Project planning and network analysis - PERT and CPM; Cost estimation.

Concrete Structures: Working stress and Limit state design concepts; Design of beams, slabs, columns; Bond and development length.

Steel Structures: Limit state design concepts; Design of tension and compression members, beams and beam-columns, column bases; Connections - simple and eccentric, Concept of plastic analysis - beams and frames.

Module 2: Geotechnical Engineering

Soil Mechanics: Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Seepage through soils – two - dimensional flow, flow nets, uplift pressure, piping, capillarity, seepage force; Principle of effective stress and quicksand condition; Compaction of soils; One- dimensional consolidation, time rate of consolidation; Shear Strength, Mohr's circle, effective and total shear strength parameters.

Foundation Engineering: Sub-surface investigations - Drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and Coulomb; Stability of slopes – Finite and infinite slopes, Bishop's method; Stress distribution in soils Boussinesq's theory; Pressure bulbs,Shallow foundations– Terzaghi's and Meyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations – dynamic and static formulae, Axial load capacity of piles in sands and clays, pile load test, pile under later all loading, pile group efficiency, negative skin friction.

Highway Pavements: Highway materials - desirable properties and tests; Desirable properties of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible and rigid pavement using IRC codes

Module 3: Water Resources Engineering

FluidMechanics:Propertiesoffluids,fluidstatics;Continuity,momentumandenergyequations and their applications; Potential flow, Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth; Concept of lift and drag.

Hydraulics: Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulics ;Channel Hydraulics-Energy-depth relationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and water surface profiles.

Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, reservoir capacity, flood estimation and routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's Law.

Irrigation: Types of irrigation systems and methods; Crop water requirements - Duty, delta, evapo-transpiration; Gravity Dams and Spillways; Lined and unlined canals, Design of weirs on permeable foundation; cross drainage structures.

Module 4: Environmental Engineering

Water and Waste Water Quality and Treatment: Basics of water quality standards – Physical, chemical and biological parameters; Water quality index; Unit processes and operations; Water requirement; Water distribution system; Drinking water treatment. Sewerage system design, quantity of domestic wastewater, primary and secondary treatment. Effluent discharge standards; Sludge disposal; Reuse of treated sewage for different applications.

Air Pollution: Types of pollutants, their sources and impacts, air pollution control, air quality standards, Air quality Index 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).

Module 5: General Civil Engineering

Linear Algebra: Matrix algebra; Systems of linear equations; Eigen values and Eigen vectors.

Calculus: Functions of single variable; Limit, continuity and differentiability; Mean value theorems, local maxima and minima; Taylor series

Probability and Statistics: Sampling theorems; Conditional probability; Descriptive statistics – Mean, median, mode and standard deviation. Linear regression.

Numerical Methods: Error analysis. Numerical solutions of linear and non-linear algebraic equations; Newton's and Lagrange polynomials. Runge Kutta Method, Gauss elimination method.

Surveying: Principles of surveying; Errors and their adjustment; Maps-scale, coordinate system; Distance and angle measurement - Levelling and trigonometric levelling; Traversing and triangulation survey; Total station; Horizontal and vertical curves. Photogrammetry and Remote Sensing - Scale, flying height; Basics of remote sensing and GIS.

Transportation Infrastructure: Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments. Geometric design of railway Track – Speed and Cant. Concept of airport runway length, calculations and corrections; taxiway and exit taxiway design.

Syllabus for P.E.T. examination

Name of Subject: Electronics Engineering

Faculty of Science and Technology

Unit-I: Electronics Devices

P-N junction diode, Zener diode, Simple diode circuits: clipping, clamping and rectifiers, BJT and MOSFETs; Single stage BJT amplifiers: biasing, bias stability, small signal analysis and frequency response, JFET and its characteristics, Pinch off voltage, Drain saturation current, JFET amplifiers and its analysis using small signal JFET model, biasing of FET. MOSFET amplifiers, LED, Photodiode.

Principle of positive and negative feedback, Concept of stability in electronics circuits, Oscillators and multivibrators, Power amplifiers.

Unit-II: Analog Circuits

Operational Amplifiers: Basic differential Amplifier using transistor and its operation, OP-Amp parameters, Characteristic and definition, Ideal OP-Amp, Equivalent circuit, Inverting and Non –Inverting configurations and design.

OP-Amp Linear and non linear applications: Voltage follower, Summing amplifier, scaling and averaging amplifier, Instrumentation amplifier and applications , Integrators and differentiators, Comparators, Schmitt trigger, clipper and clamper, Precision rectifiers, PLL.

Multivibrators: Bistable, Monostable, Astable multivibrator circuits using IC 555, Sample and hold circuits, Voltage reference circuits; Power supplies: ripple removal and regulation.

Unit-III: Networks, Signal and Systems, Control systems

Network Theorems: Superposition, Thevenin and Norton's, Maximum power transfer; Wye-Delta transformation: Time domain analysis of simple linear circuits; solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits; 2-port network parameters: driving point and transfer functions; Fourier series and Fourier transform representations, sampling theorem and applications.

Digital signal processing: Discrete time Fourier transform (DTFT), DFT, FFT, Z-Transform, LTI systems, properties, impulse response, convolution, system stability conditions. Digital filter design techniques.

Control system: Basic control system components, Feedback principle, Transfer function; block diagram representation, signal flow graph; Transient and study state analysis of LTI systems, Frequency response, Routh- Hurwitz and Nyquist stability criteria.

Unit-IV: Digital circuits & Microprocessor

Combinational circuits: Boolean algebra, minimization of functions using Boolean identities and K-map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders and PLAs; Sequential: latches and flip-flops, counters, shift registers and finite state machines; data converters: sample and hold circuits, ADC and DACs; Semiconductor memories: ROM, SRAM, DRAM; 8-bit microprocessor(8085): Block diagram, functional description and pin details- addressing modes, complete instructions set and assembler directives- interrupt processing.

Unit- V: Communication

Analog communication: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, super heterodyne receivers, circuits for analog communications; Information theory: entropy, mutual information and channel capacity theorem.

Digital Communication: 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, CDMA and OFDMA techniques.

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for PET Examination
Name of Subject: Electrical Engineering
Faculty of Science & Technology

Unit 1: Electric Circuits & Measurements

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, Network Theorems, Two-port networks, Three phase circuits, Power and power factor in ac circuits, Linear Time Invariant, Fourier series representation of continuous periodic signals, Applications of Fourier Transform, Laplace Transform

Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Different type of transducer, Data Acquisition system, Measurements of Force, Torque, Velocity, acceleration, Measurements of temperature, Pressure and Flow Measurements. Digital voltmeters and multimeters, Phase, Time and Frequency measurement; Oscilloscopes

Unit 2: Electrical Machines & Drives

Transformers:

Single phase transformer- equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Autotransformer

Three phase transformers: connections, parallel operation;

Basics of DC and AC Machines, working, characteristics and applications of DC machines, three-phase induction machine and three-phase synchronous generator. Speed control methods of three phase induction motor. speed control of DC mics

Drives: Constant power and constant torque drive, four-quadrant operation, different components of load torque.

Unit - 3: Power Systems

Power generation concepts – conventional & Renewables, 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, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles

of over-current, differential and distance protection; MCB, ELCB, fuses &Circuit breakers, Power System stability studies, Load forecasting & generation planning, concept of load flow, studies, Basic concept & working of FACT devices, Power quality issues.

Unit 4: Control systems

Basic components and their definitions, Mathematical modeling and representation of systems, Feedback principle, transfer function, open and closed loop system, Time response of system, Stability of control system, State variable methods analysis, Frequency response method of analyzing linear system, P, PI & PID controller

Unit 5: 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.

(Dr. S.M Kelo)
09.4.2021

Computer Science and Engineering-Computer Engineering

Section 1: Digital Logic and Computer Organization & Architecture

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

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).

Section 2: Programming and Data Structures & Algorithms

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

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

Section 3: Theory of Computation and Compiler Design

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

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

Section 4: Operating System and Databases

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

Section 5: 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; Fragmentation 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, Email.