PUNJAB PUBLIC SERVICE COMMISSION
COMBINED COMPETITIVE EXAMINATION (CCE) SYLLABUS

ENGINEERING FUNDAMENTALS AND ENGINEERING MANAGEMENT

Total Marks: 100

PART A: ENGINEERING FUNDAMENTALS

1. APPLIED PHYSICS:

A. Measurement and mathematical description: SI units, dimensions and dimensional consistency; scalars and vectors; significant figures; measurement uncertainty and interpretation of graphs and experimental data.

B. Classical mechanics and waves: Density; gravity; position, velocity and acceleration; mass, momentum, force and energy; angular momentum and torque; work and power; conservation laws, oscillations and engineering applications.

C. Quantum mechanics and particle physics: Planck's constant, quanta and quantization; matrix and wave mechanics at an introductory level; quantum harmonic oscillator; quantum numbers and spin; wave function; wave-particle duality; zero-point energy; Pauli's exclusion principle and Heisenberg's uncertainty principle; fundamental forces; elementary particles, antimatter, quantum gravity and vacuum energy at conceptual level.

D. Relativity: Principle of relativity; inertial frames and invariance; speed of light; length contraction and time dilation; rest mass and rest energy; gravity, general relativity and stress-energy tensor at conceptual level.

E. Optics: Ray and wave optics; reflection, refraction and scattering; lenses, mirrors and prisms; diffraction, dispersion and polarization; aberrations, optical resolution and optical instruments.

F. Solid-state physics: Amorphous and crystalline solids; crystal structures; free-electron model; valence and conduction bands, band gap, electron and hole excitation; superconductivity and crystal optics.

Suggested readings:

1. Hugh D. Young and Roger A. Freedman, Sears and Zemansky's University Physics with Modern Physics.
2. Karl F. Kuhn, Basic Physics.
3. David Halliday, Robert Resnick and Jearl Walker, Fundamentals of Physics.
4. Douglas C. Giancoli, Physics for Scientists and Engineers with Modern Physics.

2. APPLIED CHEMISTRY:

A. Chemical foundations: Atomic structure, periodic trends, chemical bonding, stoichiometry and concentration calculations; acids, bases, pH and buffers.

B. Gases, liquids and solutions: Boyle's law and Charles's law; gas constant; Dalton's partial-pressure law; Graham's diffusion law; kinetic theory and heat capacity of gases; vapour pressure and boiling point; surface tension, viscosity, refractive index, polarimetry, intermolecular and intramolecular forces; ideal and non-ideal solutions, Raoult's law and Henry's law, solubility curves and heat of solution.

C. Solid state and X-rays: Crystalline structure and properties; production of X-rays and crystal-structure applications; heat capacities of solids.

D. Electrochemistry: Electrolysis; electrolytic conductance and migration of ions; galvanic, reversible and irreversible cells; standard electrode potentials; electrochemical series, buffer solutions and engineering applications.

E. Thermochemistry and kinetics: Heat of reaction, basic chemical equilibrium and factors affecting reaction rate.

F. Industrial chemistry: Corrosion mechanisms and control; water hardness and treatment; fuels and combustion; lubricants; cement chemistry; environmental chemistry, chemical hazards and safety.

G. Basic analytical methods: Titrimetry, spectrophotometry and chromatography: principles and interpretation at introductory level.

Suggested readings:

1. P. C. Jain and Monica Jain, Engineering Chemistry.
2. Shashi Chawla, A Textbook of Engineering Chemistry.
3. S. S. Dara and S. S. Umare, A Textbook of Engineering Chemistry.
4. B. K. Sharma, Engineering Chemistry.

3. APPLIED ELECTRICITY AND ELECTRONICS:

A. Circuit fundamentals: Electrical potential; resistance, conductance, conductivity and impedance; Ohm's law; series and parallel circuits; practical resistors; work, power, energy and Joule's law; capacitance and capacitors in series/parallel; AC quantities.

Network solution methods: Kirchhoff's laws; nodal and mesh analysis; source transformation; Thevenin, Norton and maximum-power-transfer theorems.

B. Electricity and magnetism: Electric-field intensity and Gauss's theorem; capacitors, capacitance; capacitors in series and parallel; force on a current-carrying conductor; electric and magnetic circuits and leakage flux; Faraday's and Lenz's laws; induced emf/current; self and mutual inductance and series/parallel combinations; hysteresis; magnetic-field energy; generation of alternating voltage/current.

C. Machines and transformers: DC shunt, series, and compound motors; speed-torque relations; single- and three-phase induction and synchronous motors; generators; transformers; principle, construction, ratios, connections, losses, performance and efficiency.

D. Electronics and digital systems: n- and p-type materials; PN junctions and diodes; transistor types and basic circuit calculations; Class A/B and feedback amplifiers; RC oscillators; op-amps, timers, flip-flops, converters and filters.

Digital logic and embedded systems: Number systems, Boolean logic, combinational/sequential circuits, microcontrollers and embedded-system concepts.

E. Communication, signals and control: EM theory, antennas, gain, free-space loss and fading; AM, FM, PM, PWM, delta modulation, FSK, ASK and PSK; error correction, demodulation, detectors, transmitters and receivers; filters, Z-transform, S-domain, transfer functions, Nyquist criterion and stability.

F. Computing: Computer evolution; CPU, storage, input/output and multimedia; operating systems and programming languages; networks and internet; systems analysis and design; MIS and e-commerce; security, privacy and professional ethics.

G. Power systems: Network analysis; polyphase circuits; transients; transmission lines and losses.

Protection, measurement and modern power: Electrical measurements, sensors and transducers; protection and earthing; electrical safety; power factor; introductory power electronics, renewable-energy integration and smart grids.

Suggested readings:

1. B. L. Theraja and A. K. Theraja, A Textbook of Electrical Technology.
2. B. P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems.
3. William Stallings, Wireless Communications and Networks.
4. Charles K. Alexander and Matthew N. O. Sadiku, Fundamentals of Electric Circuits.
5. Stephen J. Chapman, Electric Machinery Fundamentals.
6. Thomas L. Floyd, Electronic Devices.
7. M. Morris Mano and Michael D. Ciletti, Digital Design.

4. MECHANICAL ENGINEERING FUNDAMENTALS:

A. Engineering mechanics and strength of materials: Force systems, equilibrium, friction, centroid and geometric properties; motion, work and energy; stress and strain; engineering and true stress/strain; elastic and plastic deformation; tensile testing and stress-strain curve; yield and ultimate strength; elongation, toughness, resilience, ductility and malleability; shear, bending, torsion, bending moment and principal stresses; Brinell and Rockwell hardness.

B. Fluid mechanics and machines: Fluid properties; statics and dynamics; laminar and turbulent flow and Reynolds number; continuity, momentum and energy concepts; head loss; power transmission by fluids; pumps and turbines.

C. Thermodynamics and heat transfer: Properties of fluids and steam; first and second laws; enthalpy, entropy and heat capacity; Carnot cycle; Gibbs free energy and equilibrium; PV diagrams; heat engines; two and four-stroke heat engines; steam turbines and power plants; refrigeration and air conditioning; conduction, convection and radiation; evaporators and condensers.

D. Manufacturing: Casting, forging, rolling, extrusion, wire drawing, welding, machining, turning, milling, shaping, gear cutting, drilling and fitting.

E. Machine and production practices: Basic machine elements and design considerations; metrology, limits, fits, tolerances and surface finish; engineering drawing and CAD/CAM, CNC and additive manufacturing concepts; instrumentation, condition monitoring, maintenance and workshop safety.

Suggested readings:

1. J. L. Meriam and L. G. Kraige, Engineering Mechanics: Statics.
2. William A. Nash, Schaum's Outline of Strength of Materials.
3. Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology.
4. R. C. Hibbeler, Mechanics of Materials.
5. Yunus A. Cengel and Michael A. Boles, Thermodynamics: An Engineering Approach.
6. Yunus A. Cengel and John M. Cimbala, Fluid Mechanics: Fundamentals and Applications.
7. R. S. Khurmi and J. K. Gupta, A Textbook of Machine Design.

5. MATERIALS ENGINEERING :

A. Structure of materials: Classification of materials; atomic structure and metallic bonding; crystal structures and geometry.

Crystal defects and diffusion: Point, line and surface defects; diffusion mechanisms and their engineering significance.

B. Metallic materials: Mechanical properties of metals and alloys; ferrous and non-ferrous metals and alloys; industrial applications.

Phase relations and heat treatment: Binary phase diagrams; iron-carbon system; phase transformations; annealing, normalizing, hardening and tempering.

C. Polymers, ceramics and glasses: Polymerization; general-purpose and engineering thermoplastics, thermosets and rubbers; traditional and engineering ceramics; ceramic processing and electrical, mechanical and thermal properties; glasses.

D. Composites and advanced materials: Particle-, fibre-, and laminate-reinforced composites; introductory nanomaterials, biomaterials and functional materials.

E. Behaviour, testing and selection: Tensile, hardness, impact and fatigue concepts; fracture, creep, corrosion and wear; introductory optical and electron microscopy, and X-ray characterization; material selection based on performance, cost, safety and sustainability.

Suggested readings:

1. William F. Smith and Javad Hashemi, Foundations of Materials Science and Engineering.
2. Sidney H. Avner, Introduction to Physical Metallurgy.
3. William D. Callister Jr. and David G. Rethwisch, Materials Science and Engineering: An Introduction.
4. Michael F. Ashby, Materials Selection in Mechanical Design.
5. D. R. H. Jones and Michael F. Ashby, Engineering Materials

6. CIVIL ENGINEERING FUNDAMENTALS:

A. Structures: Stress, strain, shearing force and bending moment; simply supported and cantilever beams; columns and footings; basic structural behaviour; pulleys and gears as elementary mechanics applications.

B. Civil engineering materials and construction: Properties and uses of cement, aggregates, concrete, steel, bitumen and masonry; basic construction methods, estimation and quality control.

C. Surveying and geomatics: Distance, angle and level measurement; traversing, contours and setting out; introductory total station, GNSS and GIS concepts.

D. Geotechnical engineering: Soil classification, compaction, consolidation, permeability, shear strength, bearing capacity, settlement, soil improvement, and slope stability and its mitigation at an introductory level.

E. Transportation engineering: Highway administration and scheme preparation; traffic and environmental appraisal; highway geometry, drainage, lighting, signing, communications and safety; urban roads and traffic; pavement materials and basics; maintenance and low-cost roads in developing countries.

F. Environmental engineering: Environmental impacts of water-resource and transportation projects; water supply and distribution; wastewater treatment and management.

Solid waste, pollution, and assessment: Municipal solid-waste management; air, noise and smog pollution basics; environmental-impact assessment and mitigation.

G. Hydraulics and water-resources engineering: Fluid properties; pressure- and flow-measuring devices; pipeline losses; open channels; barrages and dams.

Hydrology and resilience: Hydrologic cycle, rainfall-runoff and flood concepts; climate-resilient infrastructure, disaster-risk awareness and occupational safety.

Suggested readings:

1. A. M. Neville, Properties of Concrete.
2. T. P. Kanetkar, Surveying and Levelling.
3. E. John Finnemore and Joseph B. Franzini, Fluid Mechanics with Engineering Applications.
4. M. S. Shetty, Concrete Technology: Theory and Practice.
5. B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Surveying.
6. K. R. Arora, Soil Mechanics and Foundation Engineering.
7. L. R. Kadiyali, Traffic Engineering and Transport Planning.
8. S. K. Garg, Water Supply Engineering; and Sewage Disposal and Air Pollution Engineering.

PART B: ENGINEERING MANAGEMENT

1. ENGINEERING MANAGEMENT:

Engineering Economy, Cost and Financial Management

Cost classification and estimation; time value of money; simple and compound interest; cash-flow diagrams; present and future worth; Net Present Value (NPV)and Net Future Value (NFV); annual worth; internal rate of return; benefit-cost ratio; break-even analysis; budgeting; basic income statement and balance sheet; depreciation, inflation, replacement, life-cycle costing, financial risk and sensitivity analysis.

Project, Risk and Professional Management

Project objectives and life cycle; scope and work-breakdown structure; timelines, milestones, dependencies and Gantt charts; CPM and PERT; resource and cost estimation; resource allocation and levelling; progress monitoring; project risk identification, assessment, response and control; procurement, contracts, stakeholders, communication, change control and closure.

Professional practices and work ethics: management functions; teamwork and leadership; engineering ethics; public and environmental responsibility; occupational health and safety; technical communication and accountability.

Quality, reliability, and testing: Quality planning, assurance, control and improvement; Deming, Juran and Crosby principles; quality circles; management responsibility; purchasing and design validation; test plans, execution, records and reports; destructive and non-destructive testing; inspection, sampling, acceptance criteria, calibration and measurement uncertainty; quality audit and corrective and preventive action.

Reliability and improvement tools: PDCA; basic control charts and process capability; root-cause analysis; ISO 9001 concepts; failure modes; reliability, availability, maintainability, verification, validation and traceability.

Operations, Production, Inventory and Decision Tools:

Production and operations management; manufacturing systems; process selection and optimization; time analysis and work study; resource and raw-material planning; capacity, scheduling and production control; inventory identification and systems; FIFO and LIFO as issue and valuation methods; problem analysis, decision-support systems, decision trees, design of experiments and management tools.

Essential operations tools: ABC analysis, EOQ, reorder point, lead time and safety stock; MRP and JIT concepts; method study, process charts, work measurement and standard time; facility layout, productivity, lean principles, 5S, maintenance, safety and waste minimization; SWOT, Pareto and cause-and-effect analysis.

Suggested readings:

1. Dennis Lock, Handbook of Engineering Management.
2. O. P. Khanna, Industrial Engineering and Management.
3. T. R. Banga and S. C. Sharma, Industrial Engineering and Management Science.
4. R. Panneerselvam, Engineering Economics and Management.

5. Jay Heizer, Barry Render and Chuck Munson, Operations Management: Sustainability and Supply Chain Management.

Note: The above list is only suggestive and not exhaustive. Candidates may consult other standard books and relevant material covering the prescribed syllabus.

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