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Fundamentals of Engineering (FE)
ELECTRICAL AND COMPUTER CBT Exam Specifications

Effective Beginning with the January 2014 Examinations

- The FE exam is a computer-based test (CBT). It is closed book with an electronic reference.
- Examinees have 6 hours to complete the exam, which contains 110 multiple-choice questions. The 6-hour time also includes a tutorial and an optional scheduled break.
- The FE exam uses both the International System of Units (SI) and the US Customary System (USCS).

Knowledge	Number of Questions
1. Mathematics	**11–17**
A. Algebra and trigonometry	
B. Complex numbers	
C. Discrete mathematics	
D. Analytic geometry	
E. Calculus	
F. Differential equations	
G. Linear algebra	
H. Vector analysis	
2. Probability and Statistics	**4–6**
A. Measures of central tendencies and dispersions (e.g., mean, mode, standard deviation)	
B. Probability distributions (e.g., discrete, continuous, normal, binomial)	
C. Expected value (weighted average) in decision making	
D. Estimation for a single mean (e.g., point, confidence intervals, conditional probability)	
3. Ethics and Professional Practice	**3–5**
A. Codes of ethics (professional and technical societies)	
B. NCEES *Model Law* and *Model Rules*	
C. Intellectual property (e.g., copyright, trade secrets, patents)	
4. Engineering Economics	**3–5**
A. Time value of money (e.g., present value, future value, annuities)	
B. Cost estimation	
C. Risk identification	
D. Analysis (e.g., cost-benefit, trade-off, breakeven)	
5. Properties of Electrical Materials	**4–6**
A. Chemical (e.g., corrosion, ions, diffusion)	
B. Electrical (e.g., conductivity, resistivity, permittivity, magnetic permeability)	
C. Mechanical (e.g., piezoelectric, strength)	
D. Thermal (e.g., conductivity, expansion)	

6. Engineering Sciences **6–9**

A. Work, energy, power, heat
B. Charge, energy, current, voltage, power
C. Forces (e.g., between charges, on conductors)
D. Work done in moving a charge in an electric field (relationship between voltage and work)
E. Capacitance
F. Inductance

7. Circuit Analysis (DC and AC Steady State) **10–15**

A. KCL, KVL
B. Series/parallel equivalent circuits
C. Thevenin and Norton theorems
D. Node and loop analysis
E. Waveform analysis (e.g., RMS, average, frequency, phase, wavelength)
F. Phasors
G. Impedance

8. Linear Systems **5–8**

A. Frequency/transient response
B. Resonance
C. Laplace transforms
D. Transfer functions
E. 2-port theory

9. Signal Processing **5–8**

A. Convolution (continuous and discrete)
B. Difference equations
C. Z-transforms
D. Sampling (e.g., aliasing, Nyquist theorem)
E. Analog filters
F. Digital filters

10. Electronics **7–11**

A. Solid-state fundamentals (e.g., tunneling, diffusion/drift current, energy bands, doping bands, p-n theory)
B. Discrete devices (diodes, transistors, BJT, CMOS) and models and their performance
C. Bias circuits
D. Amplifiers (e.g., single-stage/common emitter, differential)
E. Operational amplifiers (ideal, non-ideal)
F. Instrumentation (e.g., measurements, data acquisition, transducers)
G. Power electronics

11. Power **8–12**

A. Single phase and three phase
B. Transmission and distribution
C. Voltage regulation
D. Transformers
E. Motors and generators
F. Power factor (pf)

12. Electromagnetics **5–8**

A. Maxwell equations
B. Electrostatics/magnetostatics (e.g., measurement of spatial relationships, vector analysis)
C. Wave propagation
D. Transmission lines (high frequency)
E. Electromagnetic compatibility

13. Control Systems **6–9**

A. Block diagrams (feed-forward, feedback)
B. Bode plots
C. Closed-loop and open-loop response
D. Controller performance (gain, PID), steady-state errors
E. Root locus
F. Stability
G. State variables

14. Communications **5–8**

A. Basic modulation/demodulation concepts (e.g., AM, FM, PCM)
B. Fourier transforms/Fourier series
C. Multiplexing (e.g., time division, frequency division)
D. Digital communications

15. Computer Networks **3–5**

A. Routing and switching
B. Network topologies/frameworks/models
C. Local area networks

16. Digital Systems **7–11**

A. Number systems
B. Boolean logic
C. Logic gates and circuits
D. Logic minimization (e.g., SOP, POS, Karnaugh maps)
E. Flip-flops and counters
F. Programmable logic devices and gate arrays
G. State machine design
H. Data path/controller design
I. Timing (diagrams, asynchronous inputs, races, hazards)

17. Computer Systems **4–6**

A. Architecture (e.g., pipelining, cache memory)
B. Microprocessors
C. Memory technology and systems
D. Interfacing

18. Software Development **4–6**

A. Algorithms
B. Data structures
C. Software design methods (structured, object-oriented)
D. Software implementation (e.g., procedural, scripting languages)
E. Software testing

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Fundamentals of Engineering (FE)
CHEMICAL CBT Exam Specifications

Effective Beginning with the January 2014 Examinations

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Knowledge	Number of Questions
1. Mathematics	**8–12**
A. Analytic geometry	
B. Roots of equations	
C. Calculus	
D. Differential equations	
2. Probability and Statistics	**4–6**
A. Probability distributions (e.g., discrete, continuous, normal, binomial)	
B. Expected value (weighted average) in decision making	
C. Hypothesis testing	
D. Measures of central tendencies and dispersions (e.g., mean, mode, standard deviation)	
E. Estimation for a single mean (e.g., point, confidence intervals)	
F. Regression and curve fitting	
3. Engineering Sciences	**4–6**
A. Applications of vector analysis (e.g., statics)	
B. Basic dynamics (e.g., friction, force, mass, acceleration, momentum)	
C. Work, energy, and power (as applied to particles or rigid bodies)	
D. Electricity and current and voltage laws (e.g., charge, energy, current, voltage, power, Kirchhoff, Ohm)	
4. Computational Tools	**4–6**
A. Numerical methods and concepts (e.g., convergence, tolerance)	
B. Spreadsheets for chemical engineering calculations	
C. Simulators	
5. Materials Science	**4–6**
A. Chemical, electrical, mechanical, and physical properties (e.g., effect of temperature, pressure, stress, strain)	
B. Material types and compatibilities (e.g., engineered materials, ferrous and nonferrous metals)	
C. Corrosion mechanisms and control	

6. Chemistry **8–12**

A. Inorganic chemistry (e.g., molarity, normality, molality, acids, bases, redox reactions, valence, solubility product, pH, pK, electrochemistry, periodic table)
B. Organic chemistry (e.g., nomenclature, structure, qualitative and quantitative analyses, balanced equations, reactions, synthesis, basic biochemistry)

7. Fluid Mechanics/Dynamics **8–12**

A. Fluid properties
B. Dimensionless numbers (e.g., Reynolds number)
C. Mechanical energy balance (e.g., pipes, valves, fittings, pressure losses across packed beds, pipe networks)
D. Bernoulli equation (hydrostatic pressure, velocity head)
E. Laminar and turbulent flow
F. Flow measurement (e.g., orifices, Venturi meters)
G. Pumps, turbines, and compressors
H. Compressible flow and non-Newtonian fluids

8. Thermodynamics **8–12**

A. Thermodynamic properties (e.g. specific volume, internal energy, enthalpy, entropy, free energy)
B. Properties data and phase diagrams (e.g. steam tables, psychrometric charts, T-s, P-h, x-y, T-x-y)
C. Thermodynamic laws (e.g., 1st law, 2nd law)
D. Thermodynamic processes (e.g., isothermal, adiabatic, isentropic)
E. Cyclic processes and efficiency (e.g., power, refrigeration, heat pump)
F. Phase equilibrium (e.g., fugacity, activity coefficient)
G. Chemical equilibrium
H. Heats of reaction and mixing

9. Material/Energy Balances **8–12**

A. Mass balance (steady and unsteady state)
B. Energy balance (steady and unsteady state)
C. Recycle/bypass processes
D. Reactive systems (e.g., combustion)

10. Heat Transfer **8–12**

A. Conductive heat transfer
B. Convective heat transfer (natural and forced)
C. Radiation heat transfer
D. Heat transfer coefficients (e.g., overall, local, fouling)
E. Heat transfer equipment, operation, and design (e.g., double pipe, shell and tube, fouling, number of transfer units, log-mean temperature difference, flow configuration)

11. Mass Transfer and Separation **8–12**

A. Molecular diffusion (e.g., steady and unsteady state, physical property estimation)
B. Convective mass transfer (e.g., mass transfer coefficient, eddy diffusion)
C. Separation systems (e.g., distillation, absorption, extraction, membrane processes)

D. Equilibrium stage methods (e.g., graphical methods, McCabe-Thiele, efficiency)
E. Continuous contact methods (e.g., number of transfer units, height equivalent to a theoretical plate, height of transfer unit, number of theoretical plates)
F. Humidification and drying

12. Chemical Reaction Engineering **8–12**

A. Reaction rates and order
B. Rate constant (e.g., Arrhenius function)
C. Conversion, yield, and selectivity
D. Type of reactions (e.g., series, parallel, forward, reverse, homogeneous, heterogeneous, catalysis, biocatalysis)
E. Reactor types (e.g., batch, semibatch, continuous stirred tank, plug flow, gas phase, liquid phase)

13. Process Design and Economics **8–12**

A. Process flow diagrams and piping and instrumentation diagrams
B. Equipment selection (e.g., sizing and scale-up)
C. Cost estimation
D. Comparison of economic alternatives (e.g., net present value, discounted cash flow, rate of return, expected value and risk)
E. Process design and optimization (e.g., sustainability, efficiency, green engineering, inherently safer design, evaluation of specifications)

14. Process Control **5–8**

A. Dynamics (e.g., time constants and 2nd order, underdamped, and transfer functions)
B. Control strategies (e.g., feedback, feed-forward, cascade, ratio, and PID)
C. Control loop design and hardware (e.g., matching measured and manipulated variables, sensors, control valves, and conceptual process control)

15. Safety, Health, and Environment **5–8**

A. Hazardous properties of materials (e.g., corrosivity, flammability, toxicity, reactivity, handling and storage), including MSDS
B. Industrial hygiene (e.g., noise, PPE, ergonomics)
C. Process safety and hazard analysis [e.g., layer of protection analysis, hazard and operability studies (HazOps), fault-tree analysis or event tree]
D. Overpressure and underpressure protection (e.g., relief, redundant control, intrinsically safe)
E. Waste minimization, waste treatment, and regulation (e.g., air, water, solids, RCRA, CWA, EPA, OSHA)

16. Ethics and Professional Practice **2–3**

A. Codes of ethics (professional and technical societies)
B. Agreements and contracts
C. Ethical and legal considerations
D. Professional liability
E. Public protection issues (e.g., licensing boards)

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Fundamentals of Engineering (FE)
CIVIL CBT Exam Specifications

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Knowledge	Number of Questions
1. Mathematics	**7–11**
A. Analytic geometry	
B. Calculus	
C. Roots of equations	
D. Vector analysis	
2. Probability and Statistics	**4–6**
A. Measures of central tendencies and dispersions (e.g., mean, mode, standard deviation)	
B. Estimation for a single mean (e.g., point, confidence intervals)	
C. Regression and curve fitting	
D. Expected value (weighted average) in decision making	
3. Computational Tools	**4–6**
A. Spreadsheet computations	
B. Structured programming (e.g., if-then, loops, macros)	
4. Ethics and Professional Practice	**4–6**
A. Codes of ethics (professional and technical societies)	
B. Professional liability	
C. Licensure	
D. Sustainability and sustainable design	
E. Professional skills (e.g., public policy, management, and business)	
F. Contracts and contract law	
5. Engineering Economics	**4–6**
A. Discounted cash flow (e.g., equivalence, PW, equivalent annual worth, FW, rate of return)	
B. Cost (e.g., incremental, average, sunk, estimating)	
C. Analyses (e.g., breakeven, benefit-cost, life cycle)	
D. Uncertainty (e.g., expected value and risk)	
6. Statics	**7–11**
A. Resultants of force systems	
B. Equivalent force systems	
C. Equilibrium of rigid bodies	
D. Frames and trusses	

E. Centroid of area
F. Area moments of inertia
G. Static friction

7. Dynamics **4–6**

A. Kinematics (e.g., particles and rigid bodies)
B. Mass moments of inertia
C. Force acceleration (e.g., particles and rigid bodies)
D. Impulse momentum (e.g., particles and rigid bodies)
E. Work, energy, and power (e.g., particles and rigid bodies)

8. Mechanics of Materials **7–11**

A. Shear and moment diagrams
B. Stresses and strains (e.g., axial, torsion, bending, shear, thermal)
C. Deformations (e.g., axial, torsion, bending, thermal)
D. Combined stresses
E. Principal stresses
F. Mohr's circle
G. Column analysis (e.g., buckling, boundary conditions)
H. Composite sections
I. Elastic and plastic deformations
J. Stress-strain diagrams

9. Materials **4–6**

A. Mix design (e.g., concrete and asphalt)
B. Test methods and specifications (e.g., steel, concrete, aggregates, asphalt, wood)
C. Physical and mechanical properties of concrete, ferrous and nonferrous metals, masonry, wood, engineered materials (e.g., FRP, laminated lumber, wood/plastic composites), and asphalt

10. Fluid Mechanics **4–6**

A. Flow measurement
B. Fluid properties
C. Fluid statics
D. Energy, impulse, and momentum equations

11. Hydraulics and Hydrologic Systems **8–12**

A. Basic hydrology (e.g., infiltration, rainfall, runoff, detention, flood flows, watersheds)
B. Basic hydraulics (e.g., Manning equation, Bernoulli theorem, open-channel flow, pipe flow)
C. Pumping systems (water and wastewater)
D. Water distribution systems
E. Reservoirs (e.g., dams, routing, spillways)
F. Groundwater (e.g., flow, wells, drawdown)
G. Storm sewer collection systems

12. Structural Analysis **6–9**

A. Analysis of forces in statically determinant beams, trusses, and frames
B. Deflection of statically determinant beams, trusses, and frames
C. Structural determinacy and stability analysis of beams, trusses, and frames

D. Loads and load paths (e.g., dead, live, lateral, influence lines and moving loads, tributary areas)
E. Elementary statically indeterminate structures

13. Structural Design **6–9**

A. Design of steel components (e.g., codes and design philosophies, beams, columns, beam-columns, tension members, connections)
B. Design of reinforced concrete components (e.g., codes and design philosophies, beams, slabs, columns, walls, footings)

14. Geotechnical Engineering **9–14**

A. Geology
B. Index properties and soil classifications
C. Phase relations (air-water-solid)
D. Laboratory and field tests
E. Effective stress (buoyancy)
F. Stability of retaining walls (e.g., active pressure/passive pressure)
G. Shear strength
H. Bearing capacity (cohesive and noncohesive)
I. Foundation types (e.g., spread footings, deep foundations, wall footings, mats)
J. Consolidation and differential settlement
K. Seepage/flow nets
L. Slope stability (e.g., fills, embankments, cuts, dams)
M. Soil stabilization (e.g., chemical additives, geosynthetics)
N. Drainage systems
O. Erosion control

15. Transportation Engineering **8–12**

A. Geometric design of streets and highways
B. Geometric design of intersections
C. Pavement system design (e.g., thickness, subgrade, drainage, rehabilitation)
D. Traffic safety
E. Traffic capacity
F. Traffic flow theory
G. Traffic control devices
H. Transportation planning (e.g., travel forecast modeling)

16. Environmental Engineering **6–9**

A. Water quality (ground and surface)
B. Basic tests (e.g., water, wastewater, air)
C. Environmental regulations
D. Water supply and treatment
E. Wastewater collection and treatment

17. Construction **4–6**

A. Construction documents
B. Procurement methods (e.g., competitive bid, qualifications-based)
C. Project delivery methods (e.g., design-bid-build, design build, construction management, multiple prime)
D. Construction operations and methods (e.g., lifting, rigging, dewatering and pumping, equipment production, productivity analysis and improvement, temporary erosion control)
E. Project scheduling (e.g., CPM, allocation of resources)
F. Project management (e.g., owner/contractor/client relations)
G. Construction safety
H. Construction estimating

18. Surveying **4–6**

A. Angles, distances, and trigonometry
B. Area computations
C. Earthwork and volume computations
D. Closure
E. Coordinate systems (e.g., state plane, latitude/longitude)
F. Leveling (e.g., differential, elevations, percent grades)

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Fundamentals of Engineering (FE)
ENVIRONMENTAL CBT Exam Specifications

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Knowledge	Number of Questions
1. Mathematics	**4–6**
A. Analytic geometry	
B. Numerical methods	
C. Roots of equations	
D. Calculus	
E. Differential equations	
2. Probability and Statistics	**3–5**
A. Measures of central tendencies and dispersions (e.g., mean, mode, standard deviation)	
B. Probability distributions (e.g., discrete, continuous, normal, binomial)	
C. Estimation (point, confidence intervals) for a single mean	
D. Regression and curve fitting	
E. Expected value (weighted average) in decision making	
F. Hypothesis testing	
3. Ethics and Professional Practice	**5–8**
A. Codes of ethics (professional and technical societies)	
B. Agreements and contracts	
C. Ethical and legal considerations	
D. Professional liability	
E. Public protection issues (e.g., licensing boards)	
F. Regulations (e.g., water, wastewater, air, solid/hazardous waste, groundwater/soils)	
4. Engineering Economics	**4–6**
A. Discounted cash flow (e.g., life cycle, equivalence, PW, equivalent annual worth, FW, rate of return)	
B. Cost (e.g., incremental, average, sunk, estimating)	
C. Analyses (e.g., breakeven, benefit-cost)	
D. Uncertainty (expected value and risk)	
5. Materials Science	**3–5**
A. Properties (e.g., chemical, electrical, mechanical, physical)	
B. Corrosion mechanisms and controls	
C. Material selection and compatibility	

6. Environmental Science and Chemistry **11–17**

A. Reactions (e.g., equilibrium, acid base, oxidation-reduction, precipitation)
B. Stoichiometry
C. Kinetics (chemical, microbiological)
D. Organic chemistry (e.g., nomenclature, functional group reactions)
E. Ecology (e.g., Streeter-Phelps, fluviology, limnology, eutrophication)
F. Multimedia equilibrium partitioning (e.g., Henry's law, octonal partitioning coefficient)

7. Risk Assessment **5–8**

A. Dose-response toxicity (carcinogen, noncarcinogen)
B. Exposure routes

8. Fluid Mechanics **9–14**

A. Fluid statics
B. Closed conduits (e.g., Darcy-Weisbach, Hazen-Williams, Moody)
C. Open channel (Manning)
D. Pumps (e.g., power, operating point, parallel and series)
E. Flow measurement (e.g., weirs, orifices, flowmeters)
F. Blowers (e.g., power, operating point, parallel, and series)

9. Thermodynamics **3–5**

A. Thermodynamic laws (e.g., 1st law, 2nd law)
B. Energy, heat, and work
C. Ideal gases
D. Mixture of nonreacting gases
E. Heat transfer

10. Water Resources **10–15**

A. Demand calculations
B. Population estimations
C. Runoff calculations (e.g., land use, land cover, time of concentration, duration, intensity, frequency)
D. Reservoir sizing
E. Routing (e.g., channel, reservoir)
F. Water quality and modeling (e.g., erosion, channel stability, stormwater quality management)

11. Water and Wastewater **14–21**

A. Water and wastewater characteristics
B. Mass and energy balances
C. Conventional water treatment processes (e.g., clarification, disinfection, filtration, flocculation, softening, rapid mix)
D. Conventional wastewater treatment processes (e.g., activated sludge, decentralized wastewater systems, fixed-film system, disinfection, flow equalization, headworks, lagoons)
E. Alternative treatment process (e.g., conservation and reuse, membranes, nutrient removal, ion exchange, activated carbon, air stripping)
F. Sludge treatment and handling (e.g., land application, sludge digestion, sludge dewatering)

12. Air Quality **10–15**

A. Chemical principles (e.g., ideal gas, mole fractions, stoichiometry, Henry's law)
B. Mass balances
C. Emissions (factors, rates)
D. Atmospheric sciences (e.g., stability classes, dispersion modeling, lapse rates)
E. Gas handling and treatment technologies (e.g., hoods, ducts, coolers, biofiltration, scrubbers, adsorbers, incineration)
F. Particle handling and treatment technologies (e.g., baghouses, cyclones, electrostatic precipitators, settling velocity)

13. Solid and Hazardous Waste **10–15**

A. Composting
B. Mass balances
C. Compatibility
D. Landfilling (e.g., siting, design, leachate, material and energy recovery)
E. Site characterization and remediation
F. Hazardous waste treatment (e.g., physical, chemical, thermal)
G. Radioactive waste treatment and disposal

14. Groundwater and Soils **9–14**

A. Basic hydrogeology (e.g., aquifers, permeability, water table, hydraulic conductivity, saturation, soil characteristics)
B. Drawdown (e.g., Jacob, Theis, Thiem)
C. Groundwater flow (e.g., Darcy's law, specific capacity, velocity, gradient)
D. Soil and groundwater remediation

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Fundamentals of Engineering (FE)
MECHANICAL CBT Exam Specifications

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Knowledge	Number of Questions
1. Mathematics	**6–9**
A. Analytic geometry	
B. Calculus	
C. Linear algebra	
D. Vector analysis	
E. Differential equations	
F. Numerical methods	
2. Probability and Statistics	**4–6**
A. Probability distributions	
B. Regression and curve fitting	
3. Computational Tools	**3–5**
A. Spreadsheets	
B. Flow charts	
4. Ethics and Professional Practice	**3–5**
A. Codes of ethics	
B. Agreements and contracts	
C. Ethical and legal considerations	
D. Professional liability	
E. Public health, safety, and welfare	
5. Engineering Economics	**3–5**
A. Time value of money	
B. Cost, including incremental, average, sunk, and estimating	
C. Economic analyses	
D. Depreciation	
6. Electricity and Magnetism	**3–5**
A. Charge, current, voltage, power, and energy	
B. Current and voltage laws (Kirchhoff, Ohm)	
C. Equivalent circuits (series, parallel)	
D. AC circuits	
E. Motors and generators	

7. Statics **8–12**

A. Resultants of force systems
B. Concurrent force systems
C. Equilibrium of rigid bodies
D. Frames and trusses
E. Centroids
F. Moments of inertia
G. Static friction

8. Dynamics, Kinematics, and Vibrations **9–14**

A. Kinematics of particles
B. Kinetic friction
C. Newton's second law for particles
D. Work-energy of particles
E. Impulse-momentum of particles
F. Kinematics of rigid bodies
G. Kinematics of mechanisms
H. Newton's second law for rigid bodies
I. Work-energy of rigid bodies
J. Impulse-momentum of rigid bodies
K. Free and forced vibrations

9. Mechanics of Materials **8–12**

A. Shear and moment diagrams
B. Stress types (axial, bending, torsion, shear)
C. Stress transformations
D. Mohr's circle
E. Stress and strain caused by axial loads
F. Stress and strain caused by bending loads
G. Stress and strain caused by torsion
H. Stress and strain caused by shear
I. Combined loading
J. Deformations
K. Columns

10. Material Properties and Processing **8–12**

A. Properties, including chemical, electrical, mechanical, physical, and thermal
B. Stress-strain diagrams
C. Engineered materials
D. Ferrous metals
E. Nonferrous metals
F. Manufacturing processes
G. Phase diagrams
H. Phase transformation, equilibrium, and heat treating
I. Materials selection
J. Surface conditions
K. Corrosion mechanisms and control
L. Thermal failure

M. Ductile or brittle behavior
N. Fatigue
O. Crack propagation

11. Fluid Mechanics **9–14**

A. Fluid properties
B. Fluid statics
C. Energy, impulse, and momentum
D. Internal flow
E. External flow
F. Incompressible flow
G. Compressible flow
H. Power and efficiency
I. Performance curves
J. Scaling laws for fans, pumps, and compressors

12. Thermodynamics **13–20**

A. Properties of ideal gases and pure substances
B. Energy transfers
C. Laws of thermodynamics
D. Processes
E. Performance of components
F. Power cycles, thermal efficiency, and enhancements
G. Refrigeration and heat pump cycles and coefficients of performance
H. Nonreacting mixtures of gases
I. Psychrometrics
J. Heating, ventilating, and air-conditioning (HVAC) processes
K. Combustion and combustion products

13. Heat Transfer **9–14**

A. Conduction
B. Convection
C. Radiation
D. Thermal resistance
E. Transient processes
F. Heat exchangers
G. Boiling and condensation

14. Measurements, Instrumentation, and Controls **5–8**

A. Sensors
B. Block diagrams
C. System response
D. Measurement uncertainty

15. Mechanical Design and Analysis **9–14**

A. Stress analysis of machine elements
B. Failure theories and analysis
C. Deformation and stiffness
D. Springs
E. Pressure vessels
F. Beams
G. Piping

H. Bearings
I. Power screws
J. Power transmission
K. Joining methods
L. Manufacturability
M. Quality and reliability
N. Hydraulic components
O. Pneumatic components
P. Electromechanical components

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Fundamentals of Engineering (FE)
INDUSTRIAL AND SYSTEMS CBT Exam Specifications

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Knowledge	Number of Questions
1. Mathematics	**6–9**
A. Analytic geometry	
B. Calculus	
C. Matrix operations	
D. Vector analysis	
E. Linear algebra	
2. Engineering Sciences	**5–8**
A. Work, energy, and power	
B. Material properties and selection	
C. Charge, energy, current, voltage, and power	
3. Ethics and Professional Practice	**5–8**
A. Codes of ethics and licensure	
B. Agreements and contracts	
C. Professional, ethical, and legal responsibility	
D. Public protection and regulatory issues	
4. Engineering Economics	**10–15**
A. Discounted cash flows (PW, EAC, FW, IRR, amortization)	
B. Types and breakdown of costs (e.g., fixed, variable, direct and indirect labor)	
C. Cost analyses (e.g., benefit-cost, breakeven, minimum cost, overhead)	
D. Accounting (financial statements and overhead cost allocation)	
E. Cost estimation	
F. Depreciation and taxes	
G. Capital budgeting	
5. Probability and Statistics	**10–15**
A. Combinatorics (e.g., combinations, permutations)	
B. Probability distributions (e.g., normal, binomial, empirical)	
C. Conditional probabilities	
D. Sampling distributions, sample sizes, and statistics (e.g., central tendency, dispersion)	
E. Estimation (e.g., point, confidence intervals)	
F. Hypothesis testing	
G. Regression (linear, multiple)	

H. System reliability (e.g., single components, parallel and series systems)
I. Design of experiments (e.g., ANOVA, factorial designs)

6. Modeling and Computations **8–12**

A. Algorithm and logic development (e.g., flow charts, pseudocode)
B. Databases (e.g., types, information content, relational)
C. Decision theory (e.g., uncertainty, risk, utility, decision trees)
D. Optimization modeling (e.g., decision variables, objective functions, and constraints)
E. Linear programming (e.g., formulation, primal, dual, graphical solutions)
F. Mathematical programming (e.g., network, integer, dynamic, transportation, assignment)
G. Stochastic models (e.g., queuing, Markov, reliability)
H. Simulation

7. Industrial Management **8–12**

A. Principles (e.g., planning, organizing, motivational theory)
B. Tools of management (e.g., MBO, reengineering, organizational structure)
C. Project management (e.g., scheduling, PERT, CPM)
D. Productivity measures

8. Manufacturing, Production, and Service Systems **8–12**

A. Manufacturing processes
B. Manufacturing systems (e.g., cellular, group technology, flexible)
C. Process design (e.g., resources, equipment selection, line balancing)
D. Inventory analysis (e.g., EOQ, safety stock)
E. Forecasting
F. Scheduling (e.g., sequencing, cycle time, material control)
G. Aggregate planning
H. Production planning (e.g., JIT, MRP, ERP)
I. Lean enterprises
J. Automation concepts (e.g., robotics, CIM)
K. Sustainable manufacturing (e.g., energy efficiency, waste reduction)
L. Value engineering

9. Facilities and Logistics **8–12**

A. Flow measurements and analysis (e.g., from/to charts, flow planning)
B. Layouts (e.g., types, distance metrics, planning, evaluation)
C. Location analysis (e.g., single- and multiple-facility location, warehouses)
D. Process capacity analysis (e.g., number of machines and people, trade-offs)
E. Material handling capacity analysis
F. Supply chain management and design

10. Human Factors, Ergonomics, and Safety **8–12**

A. Hazard identification and risk assessment
B. Environmental stress assessment (e.g., noise, vibrations, heat)
C. Industrial hygiene
D. Design for usability (e.g., tasks, tools, displays, controls, user interfaces)
E. Anthropometry
F. Biomechanics
G. Cumulative trauma disorders (e.g., low back injuries, carpal tunnel syndrome)

H. Systems safety
I. Cognitive engineering (e.g., information processing, situation awareness, human error, mental models)

11. Work Design **8–12**

A. Methods analysis (e.g., charting, workstation design, motion economy)
B. Time study (e.g., time standards, allowances)
C. Predetermined time standard systems (e.g., MOST, MTM)
D. Work sampling
E. Learning curves

12. Quality **8–12**

A. Six sigma
B. Management and planning tools (e.g., fishbone, Pareto, QFD, TQM)
C. Control charts
D. Process capability and specifications
E. Sampling plans
F. Design of experiments for quality improvement
G. Reliability engineering

13. Systems Engineering **8–12**

A. Requirements analysis
B. System design
C. Human systems integration
D. Functional analysis and allocation
E. Configuration management
F. Risk management
G. Verification and assurance
H. System life-cycle engineering

NCEES
advancing licensure for engineers and surveyors

Fundamentals of Engineering (FE)
OTHER DISCIPLINES CBT Exam Specifications

Effective Beginning with the January 2014 Examinations

- The FE exam is a computer-based test (CBT). It is closed book with an electronic reference.
- Examinees have 6 hours to complete the exam, which contains 110 multiple-choice questions. The 6-hour time also includes a tutorial and an optional scheduled break.
- The FE exam uses both the International System of Units (SI) and the US Customary System (USCS).

Knowledge	Number of Questions
1. Mathematics and Advanced Engineering Mathematics	**12–18**
A. Analytic geometry and trigonometry	
B. Calculus	
C. Differential equations (e.g., homogeneous, nonhomogeneous, Laplace transforms)	
D. Numerical methods (e.g., algebraic equations, roots of equations, approximations, precision limits)	
E. Linear algebra (e.g., matrix operations)	
2. Probability and Statistics	**6–9**
A. Measures of central tendencies and dispersions (e.g., mean, mode, variance, standard deviation)	
B. Probability distributions (e.g., discrete, continuous, normal, binomial)	
C. Estimation (e.g., point, confidence intervals)	
D. Expected value (weighted average) in decision making	
E. Sample distributions and sizes	
F. Goodness of fit (e.g., correlation coefficient, least squares)	
3. Chemistry	**7–11**
A. Periodic table (e.g., nomenclature, metals and nonmetals, atomic structure of matter)	
B. Oxidation and reduction	
C. Acids and bases	
D. Equations (e.g., stoichiometry, equilibrium)	
E. Gas laws (e.g., Boyle's and Charles' Laws, molar volume)	
4. Instrumentation and Data Acquisition	**4–6**
A. Sensors (e.g., temperature, pressure, motion, pH, chemical constituents)	
B. Data acquisition (e.g., logging, sampling rate, sampling range, filtering, amplification, signal interface)	
C. Data processing (e.g., flow charts, loops, branches)	
5. Ethics and Professional Practice	**3–5**
A. Codes of ethics	
B. NCEES *Model Law* and *Model Rules*	
C. Public protection issues (e.g., licensing boards)	

6. Safety, Health, and Environment **4–6**

A. Industrial hygiene (e.g., carcinogens, toxicology, MSDS, lower exposure limits)
B. Basic safety equipment (e.g., pressure relief valves, emergency shut-offs, fire prevention and control, personal protective equipment)
C. Gas detection and monitoring (e.g., O_2, CO, CO_2, CH_4, H_2S, Radon)
D. Electrical safety

7. Engineering Economics **7–11**

A. Time value of money (e.g., present worth, annual worth, future worth, rate of return)
B. Cost (e.g., incremental, average, sunk, estimating)
C. Economic analyses (e.g., breakeven, benefit-cost, optimal economic life)
D. Uncertainty (e.g., expected value and risk)
E. Project selection (e.g., comparison of unequal life projects, lease/buy/make, depreciation, discounted cash flow)

8. Statics **8–12**

A. Resultants of force systems and vector analysis
B. Concurrent force systems
C. Force couple systems
D. Equilibrium of rigid bodies
E. Frames and trusses
F. Area properties (e.g., centroids, moments of inertia, radius of gyration)
G. Static friction

9. Dynamics **7–11**

A. Kinematics
B. Linear motion (e.g., force, mass, acceleration)
C. Angular motion (e.g., torque, inertia, acceleration)
D. Mass moment of inertia
E. Impulse and momentum (linear and angular)
F. Work, energy, and power
G. Dynamic friction
H. Vibrations

10. Strength of Materials **8–12**

A. Stress types (e.g., normal, shear, bending, torsion)
B. Combined stresses
C. Stress and strain caused by axial loads, bending loads, torsion, or shear
D. Shear and moment diagrams
E. Analysis of beams, trusses, frames, and columns
F. Deflection and deformations (e.g., axial, bending, torsion)
G. Elastic and plastic deformation
H. Failure theory and analysis (e.g., static/dynamic, creep, fatigue, fracture, buckling)

11. Materials Science **6–9**

A. Physical, mechanical, chemical, and electrical properties of ferrous metals
B. Physical, mechanical, chemical, and electrical properties of nonferrous metals
C. Physical, mechanical, chemical, and electrical properties of engineered materials (e.g., polymers, concrete, composites)
D. Corrosion mechanisms and control

12. Fluid Mechanics and Dynamics of Liquids **8–12**

A. Fluid properties (e.g., Newtonian, non-Newtonian)
B. Dimensionless numbers (e.g., Reynolds number, Froude number)
C. Laminar and turbulent flow
D. Fluid statics
E. Energy, impulse, and momentum equations (e.g., Bernoulli equation)
F. Pipe flow and friction losses (e.g., pipes, valves, fittings, Darcy-Weisbach equation, Hazen-Williams equation)
G. Open-channel flow (e.g., Manning equation, drag)
H. Fluid transport systems (e.g., series and parallel operations)
I. Flow measurement
J. Turbomachinery (e.g., pumps, turbines)

13. Fluid Mechanics and Dynamics of Gases **4–6**

A. Fluid properties (e.g., ideal and non-ideal gases)
B. Dimensionless numbers (e.g., Reynolds number, Mach number)
C. Laminar and turbulent flow
D. Fluid statics
E. Energy, impulse, and momentum equations
F. Duct and pipe flow and friction losses
G. Fluid transport systems (e.g., series and parallel operations)
H. Flow measurement
I. Turbomachinery (e.g., fans, compressors, turbines)

14. Electricity, Power, and Magnetism **7–11**

A. Electrical fundamentals (e.g., charge, current, voltage, resistance, power, energy)
B. Current and voltage laws (Kirchhoff, Ohm)
C. DC circuits
D. Equivalent circuits (series, parallel, Norton's theorem, Thevenin's theorem)
E. Capacitance and inductance
F. AC circuits (e.g., real and imaginary components, complex numbers, power factor, reactance and impedance)
G. Measuring devices (e.g., voltmeter, ammeter, wattmeter)

15. Heat, Mass, and Energy Transfer **9–14**

A. Energy, heat, and work
B. Thermodynamic laws (e.g., 1st law, 2nd law)
C. Thermodynamic equilibrium
D. Thermodynamic properties (e.g., entropy, enthalpy, heat capacity)
E. Thermodynamic processes (e.g., isothermal, adiabatic, reversible, irreversible)
F. Mixtures of nonreactive gases
G. Heat transfer (e.g., conduction, convection, and radiation)
H. Mass and energy balances
I. Property and phase diagrams (e.g., T-s, P-h)
J. Phase equilibrium and phase change
K. Combustion and combustion products (e.g., CO, CO_2, NO_X, ash, particulates)
L. Psychrometrics (e.g., relative humidity, wet-bulb)