Fundamentals of Engineering (FE) exam

The Fundamentals of Engineering (FE) exam is generally your first step in the process to becoming a professional licensed engineer (P.E.). It is designed for recent graduates and students who are close to finishing an undergraduate engineering degree from an EAC/ABET-accredited program. The FE exam is a computer-based exam administered year-round at NCEES-approved Pearson VUE test centers.

The FE exam includes 110-questions. The exam appointment time is 6 hours long and includes: Nondisclosure agreement (2 minutes), tutorial (8 minutes), exam (5 hours and 20 minutes), and a scheduled break (25 minutes). Learn more at the NCEES YouTube channel.

Register for a FE exam by logging in to your MyNCEES account and following the onscreen instructions. Prepare for the FE exam by:

- Reviewing the FE exam specifications: https://ncees.org/engineering/fe/
- Reading the reference materials: https://ncees.org/exams/exam-preparation-materials/
- Choosing an approved calculator: (https://ncees.org/exams/calculator/)
- Understanding scoring and reporting: https://ncees.org/exams/scores/

A $175 exam fee is payable directly to NCEES. Some licensing boards may require you to file a separate application and pay an application fee as part of the approval process to qualify you for a seat for an NCEES exam. Your licensing board may have additional requirements. Special accommodations are available for examinees who meet certain eligibility criteria and sufficiently document their request.

Scoring and reporting

FE exam results are typically available 7–10 days after you take the exam. You will receive an email notification from NCEES with instructions to view your results in your MyNCEES account. Results include information specific to your licensing board regarding how you should proceed based on your performance.

Pass rates

The pass rates below represent FE examinees who:

- Took the FE exam for the first time
- Attended EAC/ABET-accredited engineering programs
- Took the FE exam within 12 months of graduation

Exam	Volume	Pass rate	Format	Availability	Last updated
FE Chemical	304	69%	CBT	Year-round	Jan 2023
FE Civil	3,540	55%	CBT	Year-round	Jan 2023
FE Electrical and Computer	732	64%	CBT	Year-round	Jan 2023
FE Environmental	396	64%	CBT	Year-round	Jan 2023
FE Industrial and Systems	88	51%	CBT	Year-round	Jan 2023
FE Mechanical	2,029	65%	CBT	Year-round	Jan 2023
FE Other Disciplines	404	55%	CBT	Year-round	Jan 2023

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Fundamentals of Engineering (FE)
CHEMICAL CBT Exam Specifications

Effective Beginning with the July 2020 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 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 U.S. Customary System (USCS).

Knowledge	Number of Questions
1. Mathematics	**6–9**
A. Analytic geometry, logarithms, and trigonometry	
B. Calculus (e.g., single-variable, integral, differential)	
C. Differential equations (e.g., ordinary, partial, Laplace)	
D. Numerical methods (e.g., error propagation, Taylor's series, curve fitting, Newton-Raphson, Fourier series)	
E. Algebra (e.g., fundamentals, matrix algebra, systems of equations)	
F. Accuracy, precision, and significant figures	
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 and design of experiments (e.g., t-test, outlier testing, analysis of the variance)	
D. Measures of central tendencies and dispersions (e.g., mean, mode, standard deviation, confidence intervals)	
E. Regression and curve fitting	
F. Statistical control (e.g., control limits)	
3. Engineering Sciences	**4–6**
A. Basic dynamics (e.g., friction, force, mass, acceleration, momentum)	
B. Work, energy, and power (as applied to particles or rigid bodies)	
C. Electricity, current, and voltage laws (e.g., charge, energy, current, voltage, power, Kirchhoff's law, Ohm's law)	
4. Materials Science	**4–6**
A. Chemical, electrical, mechanical, and physical properties (e.g., effect of temperature, pressure, stress, strain, failure)	
B. Material types and compatibilities (e.g., engineered materials, ferrous and nonferrous metals)	
C. Corrosion mechanisms and control	
D. Polymers, ceramics, and composites	

5. Chemistry and Biology **7–11**

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, balanced equations, reactions, synthesis)
C. Analytical chemistry (e.g., wet chemistry and instrumental chemistry)
D. Biochemistry, microbiology, and molecular biology (e.g., organization and function of the cell; Krebs, glycolysis, Calvin cycles; enzymes and protein chemistry; genetics; protein synthesis, translation, transcription)
E. Bioprocessing (e.g., fermentation, biological treatment systems, aerobic, anaerobic process, nutrient removal)

6. 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, compressors, and vacuum systems
H. Compressible flow and non-Newtonian fluids

7. Thermodynamics **8–12**

A. Thermodynamic properties of pure components and mixtures (e.g., specific volume, internal energy, enthalpy, entropy, free energy, ideal gas law)
B. Properties data and phase diagrams of pure components and mixtures (e.g., steam tables, psychrometric charts, T-s, P-h, x-y, T-x-y)
C. Thermodynamic laws (e.g., first law, second law)
D. Thermodynamic processes (e.g., isothermal, adiabatic, isentropic, phase changes)
E. Cyclic processes and efficiencies (e.g., power, refrigeration, heat pump)
F. Phase equilibrium (e.g., fugacity, activity coefficient, Raoult's law)
G. Chemical equilibrium
H. Heats of reaction and mixing

8. Material/Energy Balances **10–15**

A. Steady-state mass balance
B. Unsteady-state mass balance
C. Steady-state energy balance
D. Unsteady-state energy balance
E. Recycle/bypass processes
F. Reactive systems (e.g., combustion)

9. 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)

10. 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, adsorption)
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, drying, and evaporation

11. Solids Handling **3–5**

A. Particle properties (e.g., surface and bulk forces, particle size distribution)
B. Processing (e.g., crushing, grinding, crystallization)
C. Transportation and storage (e.g., belts, pneumatic, slurries, tanks, hoppers)

12. Chemical Reaction Engineering **7–11**

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, biological)
E. Reactor types (e.g., batch, semibatch, continuous stirred tank, plug flow, gas phase, liquid phase)
F. Catalysis (e.g., mechanisms, biocatalysis, physical properties)

13. Economics **4–6**

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

14. Process Design **7–11**

A. Process flow diagrams and piping and instrumentation diagrams
B. Equipment selection (e.g., sizing and scale-up)
C. Equipment and facilities cost estimation (e.g., cost indices, equipment costing)
D. Process design and optimization (e.g., sustainability, efficiency, green engineering, inherently safer design, evaluation of specifications, product design)
E. Design standards (e.g., regulatory, ASTM, ISO, OSHA)

15. Process Control **4–6**

A. Dynamics (e.g., first- and second-order processes, gains and time constants, stability, damping, and transfer functions)
B. Control strategies (e.g., feedback, feedforward, cascade, ratio, PID controller tuning, alarms, other safety equipment)
C. Control loop design and hardware (e.g., matching measured and manipulated variables, sensors, control valves, conceptual process control, distributed control system [DCS] programming, programmable logic controller [PLC] programming, interlocks)

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

A. Hazardous properties of materials, including SDS (e.g., corrosivity, flammability, toxicity, reactivity, handling, storage, transportation)
B. Industrial hygiene (e.g., toxicity, noise, PPE, ergonomics)
C. Process safety, risk assessment, and hazard analysis (e.g., layer of protection analysis, hazard and operability [HAZOP] studies, fault and event tree analysis, dispersion modeling)
D. Overpressure and underpressure protection (e.g., relief, redundant control, inherently safe)
E. Waste minimization, waste treatment, and regulation (e.g., air, water, solids, RCRA, CWA, other EPA, OSHA)
F. Reactivity hazards (e.g., inerting, runaway reactions, compatibility)

17. Ethics and Professional Practice **3–5**

A. Codes of ethics (professional and technical societies)
B. Agreements, contracts, and contract law (e.g., noncompete, nondisclosure, memorandum of understanding)
C. Public health, safety, and welfare (e.g., public protection issues, licensing, professional liability, regulatory issues)
D. Intellectual property (e.g., copyright, trade secrets, patents, trademarks)

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Fundamentals of Engineering (FE)
CIVIL CBT Exam Specifications

Effective Beginning with the July 2020 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 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 U.S. Customary System (USCS).

Knowledge	Number of Questions
1. Mathematics and Statistics	**8–12**
A. Analytic geometry	
B. Single-variable calculus	
C. Vector operations	
D. Statistics (e.g., distributions, mean, mode, standard deviation, confidence interval, regression and curve fitting)	
2. Ethics and Professional Practice	**4–6**
A. Codes of ethics (professional and technical societies)	
B. Professional liability	
C. Licensure	
D. Contracts and contract law	
3. Engineering Economics	**5–8**
A. Time value of money (e.g., equivalence, present worth, equivalent annual worth, future worth, rate of return)	
B. Cost (e.g., fixed, variable, direct and indirect labor, incremental, average, sunk)	
C. Analyses (e.g., break-even, benefit-cost, life cycle, sustainability, renewable energy)	
D. Uncertainty (e.g., expected value and risk)	
4. Statics	**8–12**
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	

5. Dynamics **4–6**

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

6. Mechanics of Materials **7–11**

A. Shear and moment diagrams
B. Stresses and strains (e.g., diagrams, axial, torsion, bending, shear, thermal)
C. Deformations (e.g., axial, torsion, bending, thermal)
D. Combined stresses, principal stresses, and Mohr's circle

7. Materials **5–8**

A. Mix design of concrete and asphalt
B. Test methods and specifications of metals, concrete, aggregates, asphalt, and wood
C. Physical and mechanical properties of metals, concrete, aggregates, asphalt, and wood

8. Fluid Mechanics **6–9**

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

9. Surveying **6–9**

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

10. Water Resources and Environmental Engineering **10–15**

A. Basic hydrology (e.g., infiltration, rainfall, runoff, watersheds)
B. Basic hydraulics (e.g., Manning equation, Bernoulli theorem, open-channel flow)
C. Pumps
D. Water distribution systems
E. Flood control (e.g., dams, routing, spillways)
F. Stormwater (e.g., detention, routing, quality)
G. Collection systems (e.g., wastewater, stormwater)
H. Groundwater (e.g., flow, wells, drawdown)
I. Water quality (e.g., ground and surface, basic water chemistry)
J. Testing and standards (e.g., water, wastewater, air, noise)
K. Water and wastewater treatment (e.g., biological processes, softening, drinking water treatment)

11. Structural Engineering **10–15**

A. Analysis of statically determinant beams, columns, trusses, and frames
B. Deflection of statically determinant beams, trusses, and frames
C. Column analysis (e.g., buckling, boundary conditions)
D. Structural determinacy and stability analysis of beams, trusses, and frames
E. Elementary statically indeterminate structures
F. Loads, load combinations, and load paths (e.g., dead, live, lateral, influence lines and moving loads, tributary areas)
G. Design of steel components (e.g., codes and design philosophies, beams, columns, tension members, connections)
H. Design of reinforced concrete components (e.g., codes and design philosophies, beams, columns)

12. Geotechnical Engineering **10–15**

A. Index properties and soil classifications
B. Phase relations
C. Laboratory and field tests
D. Effective stress
E. Stability of retaining structures (e.g., active/passive/at-rest pressure)
F. Shear strength
G. Bearing capacity
H. Foundation types (e.g., spread footings, deep foundations, wall footings, mats)
I. Consolidation and differential settlement
J. Slope stability (e.g., fills, embankments, cuts, dams)
K. Soil stabilization (e.g., chemical additives, geosynthetics)

13. Transportation Engineering **9–14**

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

14. Construction Engineering **8–12**

A. Project administration (e.g., documents, management, procurement, project delivery methods)
B. Construction operations and methods (e.g., safety, equipment, productivity analysis, temporary erosion control)
C. Project controls (e.g., earned value, scheduling, allocation of resources, activity relationships)
D. Construction estimating
E. Interpretation of engineering drawings

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

Effective Beginning with the July 2020 Examinations

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- Examinees have 6 hours to complete the exam, which contains 110 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 U.S. 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 (e.g., differential, integral, single-variable, multivariable)	
F. Ordinary 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, conditional probability)	
C. Expected value (weighted average)	
3. Ethics and Professional Practice	**4–6**
A. Codes of ethics (e.g., professional and technical societies, NCEES *Model Law* and *Model Rules*)	
B. Intellectual property (e.g., copyright, trade secrets, patents, trademarks)	
C. Safety (e.g., grounding, material safety data, PPE, radiation protection)	
4. Engineering Economics	**5–8**
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, break-even)	

5. Properties of Electrical Materials **4–6**

A. Semiconductor materials (e.g., tunneling, diffusion/drift current, energy bands, doping bands, p-n theory)
B. Electrical (e.g., conductivity, resistivity, permittivity, magnetic permeability, noise)
C. Thermal (e.g., conductivity, expansion)

6. Circuit Analysis (DC and AC Steady State) **11–17**

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

7. Linear Systems **5–8**

A. Frequency/transient response
B. Resonance
C. Laplace transforms
D. Transfer functions

8. Signal Processing **5–8**

A. Sampling (e.g., aliasing, Nyquist theorem)
B. Analog filters
C. Digital filters (e.g., difference equations, Z-transforms)

9. Electronics **7–11**

A. Models, biasing, and performance of discrete devices (e.g., diodes, transistors, thyristors)
B. Amplifiers (e.g., single-stage/common emitter, differential, biasing)
C. Operational amplifiers (e.g., ideal, nonideal)
D. Instrumentation (e.g., measurements, data acquisition, transducers)
E. Power electronics (e.g., rectifiers, inverters, converters)

10. Power Systems **8–12**

A. Power theory (e.g., power factor, single and three phase, voltage regulation)
B. Transmission and distribution (e.g., real and reactive losses, efficiency, voltage drop, delta and wye connections)
C. Transformers (e.g., single-phase and three-phase connections, reflected impedance)
D. Motors and generators (e.g., synchronous, induction, dc)

11. Electromagnetics **4–6**

A. Electrostatics/magnetostatics (e.g., spatial relationships, vector analysis)
B. Electrodynamics (e.g., Maxwell equations, wave propagation)
C. Transmission lines (high frequency)

12. Control Systems **6–9**

A. Block diagrams (e.g. feedforward, feedback)
B. Bode plots
C. Closed-loop response, open-loop response, and stability
D. Controller performance (e.g., steady-state errors, settling time, overshoot)

13. 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, code division)
D. Digital communications

14. Computer Networks **4–6**

A. Routing and switching
B. Network topologies (e.g., mesh, ring, star)
C. Network types (e.g., LAN, WAN, internet)
D. Network models (e.g., OSI, TCP/IP)
E. Network intrusion detection and prevention (e.g., firewalls, endpoint detection, network detection)
F. Security (e.g., port scanning, network vulnerability testing, web vulnerability testing, penetration testing, security triad)

15. Digital Systems **8–12**

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. Timing (e.g., diagrams, asynchronous inputs, race conditions and other hazards)

16. Computer Systems **5–8**

A. Microprocessors
B. Memory technology and systems
C. Interfacing

17. Software Engineering **4–6**

A. Algorithms (e.g., sorting, searching, complexity, big-O)
B. Data structures (e.g., lists, trees, vectors, structures, arrays)
C. Software implementation (e.g., iteration, conditionals, recursion, control flow, scripting, testing)

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Fundamentals of Engineering (FE)
ENVIRONMENTAL CBT Exam Specifications

Effective Beginning with the July 2020 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 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 U.S. Customary System (USCS).

Knowledge	Number of Questions
1. Mathematics	**5–8**
A. Analytic geometry and trigonometry	
B. Algebraic equations and roots	
C. Calculus (e.g., differential, integral, differential equations)	
D. Numerical methods (e.g., numerical integration, approximations, precision limits, error propagation)	
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. Estimation for a single mean (e.g., point, confidence intervals)	
D. Regression (linear, multiple), curve fitting, and goodness of fit (e.g., correlation coefficient, least squares)	
E. Hypothesis testing (e.g., t-test, outlier testing, analysis of the variance)	
3. Ethics and Professional Practice	**5–8**
A. Codes of ethics (e.g., professional and technical societies, ethical and legal considerations)	
B. Public health, safety, and welfare (e.g., public protection issues, licensing boards, professional liability)	
C. Compliance with codes, standards, and regulations (e.g., CWA, CAA, RCRA, CERCLA, SDWA, NEPA, OSHA)	
D. Engineer's role in society (e.g., sustainability, resiliency, long-term viability)	
4. Engineering Economics	**5–8**
A. Time value of money (e.g., equivalence, present worth, equivalent annual worth, future worth, rate of return, annuities)	
B. Cost types and breakdowns (e.g., fixed, variable, direct and indirect labor, incremental, average, sunk, O&M)	
C. Economic analyses (e.g., benefit-cost, break-even, minimum cost, overhead, life cycle)	
D. Project selection (e.g., comparison of projects with unequal lives, lease/buy/make, depreciation, discounted cash flow)	

5. Fundamental Principles **7–11**

A. Population projections and demand calculations (e.g., water, wastewater, solid waste, energy)
B. Reactors
C. Materials science (e.g., properties, corrosion, compatibility, stress strain)

6. Environmental Chemistry **7–11**

A. Stoichiometry and chemical reactions (e.g., equilibrium, acid-base, oxidation-reduction, precipitation, pC-pH)
B. Kinetics (e.g., chemical conversion, growth and decay)
C. Organic chemistry (e.g., nomenclature, functional group reactions)
D. Multimedia equilibrium partitioning (e.g., Henry's law, octanol partitioning coefficient)

7. Health Hazards and Risk Assessment **4–6**

A. Dose-response toxicity (e.g., carcinogen, noncarcinogen)
B. Exposure routes and pathways
C. Occupational health (e.g., PPE, noise pollution, safety screening)

8. Fluid Mechanics and Hydraulics **12–18**

A. Fluid statics (e.g., pressure, force analysis)
B. Closed conduits (e.g., Darcy-Weisbach, Hazen-Williams, Moody)
C. Open channel (e.g., Manning, supercritical/subcritical, culverts, hydraulic elements)
D. Pumps (e.g., power, operating point, parallel, series)
E. Flow measurement (e.g., weirs, orifices, flumes)
F. Blowers (e.g., power, inlet/outlet pressure, efficiency, operating point, parallel, series)
G. Fluid dynamics (e.g., Bernoulli, laminar flow, turbulent flow, continuity equation)
H. Steady and unsteady flow

9. Thermodynamics **3–5**

A. Thermodynamic laws (e.g., first law, second law)
B. Energy, heat, and work (e.g., efficiencies, coefficient of performance, energy cycles, energy conversion, conduction, convection, radiation)
C. Behavior of ideal gases

10. Surface Water Resources and Hydrology **9–14**

A. Runoff calculations (e.g., land use, land cover, time of concentration, duration, intensity, frequency, runoff control, runoff management)
B. Water storage sizing (e.g., reservoir, detention and retention basins)
C. Routing (e.g., channel, reservoir)
D. Water quality and modeling (e.g., erosion, channel stability, stormwater quality management, wetlands, Streeter-Phelps, eutrophication)
E. Water budget (e.g., evapotranspiration, precipitation, infiltration, soil moisture, storage)

11. Groundwater, Soils, and Sediments **8–12**

A. Basic hydrogeology (e.g., aquifer properties, soil characteristics, subsurface)
B. Groundwater flow (e.g., Darcy's law, specific capacity, velocity, gradient, transport mechanisms)
C. Drawdown (e.g., Dupuit, Jacob, Theis, Thiem)
D. Remediation of soil, sediment, and/or groundwater (e.g., recovery, ex-situ/in-situ treatment)

12. Water and Wastewater **12–18**

A. Water and wastewater characteristics (e.g., physical, chemical, biological, nutrients)
B. Mass balance and loading rates (e.g., removal efficiencies)
C. Physical processes (e.g., sedimentation/clarification, filtration, adsorption, membrane, flocculation, headworks, flow equalization, air stripping, activated carbon)
D. Chemical processes (e.g., disinfection, ion exchange, softening, coagulation, precipitation)
E. Biological processes (e.g., activated sludge, fixed film, lagoons, phytoremediation, aerobic, anaerobic, anoxic)
F. Sludge treatment and handling (e.g., land application, digestion, sludge dewatering, composting)
G. Water conservation and reuse

13. Air Quality and Control **8–12**

A. Ambient and indoor air quality (e.g., criteria, toxic and hazardous air pollutants)
B. Mass and energy balances (e.g., STP basis, loading rates, heating values)
C. Emissions (e.g., factors, rates)
D. Atmospheric modeling and meteorology (e.g., stability classes, dispersion modeling, lapse rates)
E. Gas treatment technologies (e.g., biofiltration, scrubbers, adsorbers, incineration, catalytic reducers)
F. Particle treatment technologies (e.g., baghouses, cyclones, electrostatic precipitators)
G. Indoor air quality modeling and controls (e.g., air exchanges, steady- and nonsteady-state reactor model)

14. Solid and Hazardous Waste **7–11**

A. Mass and energy balances
B. Solid waste management (e.g., collection, transportation, storage, composting, recycling, waste to energy)
C. Solid waste disposal (e.g., landfills, leachate and gas collection)
D. Hazardous waste compatibility
E. Site characterization (e.g., sampling, monitoring, remedial investigation)
F. Hazardous and radioactive waste treatment and disposal (e.g., physical, chemical, thermal, biological)

15. Energy and Environment **4–6**

A. Energy sources concepts (e.g., conventional and alternative)
B. Environmental impact of energy sources and production (e.g., greenhouse gas production, carbon footprint, thermal, water needs)

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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 (e.g., areas, volumes)	
B. Calculus (e.g., derivatives, integrals, progressions, series)	
C. Linear algebra (e.g., matrix operations, vector analysis)	
2. Engineering Sciences	**4–6**
A. Thermodynamics and fluid mechanics	
B. Statics, dynamics, and materials	
C. Electricity and electrical circuits	
3. Ethics and Professional Practice	**4–6**
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	**9–14**
A. Discounted cash flows (e.g., nonannual compounding, time value of money)	
B. Evaluation of alternatives (e.g., PW, EAC, FW, IRR, benefit-cost)	
C. Cost analyses (e.g., fixed/variable, break-even, estimating, overhead, inflation, incremental, sunk, replacement)	
D. Depreciation and taxes (e.g., MACRS, straight line, after-tax cash flow, recapture)	
5. Probability and Statistics	**10–15**
A. Probabilities (e.g., permutations and combinations, sets, laws of probability)	
B. Probability distributions and functions (e.g., types, statistics, central limit theorem, expected value, linear combinations)	
C. Estimation, confidence intervals, and hypothesis testing (e.g., normal, t, chi-square, types of error, sample size)	
D. Linear regression (e.g., parameter estimation, residual analysis, correlation)	
E. Design of experiments (e.g., ANOVA, factorial designs)	

6. Modeling and Quantitative Analysis **9–14**

A. Data, logic development, and analytics (e.g., databases, flowcharts, algorithms, data science techniques)
B. Linear programming and optimization (e.g., formulation, solution, interpretation)
C. Stochastic models and simulation (e.g., queuing, Markov processes, inverse probability functions)

7. Engineering Management **8–12**

A. Principles and tools (e.g., planning, organizing, motivational theory, organizational structure)
B. Project management (e.g., WBS, scheduling, PERT, CPM, earned value, agile)
C. Performance measurement (e.g., KPIs, productivity, wage scales, balance scorecard, customer satisfaction)
D. Decision making and risk (e.g., uncertainty, utility, decision trees, financial risk)

8. Manufacturing, Service, and Other Production Systems **9–14**

A. Manufacturing processes (e.g., machining, casting, welding, forming, dimensioning, new technologies)
B. Manufacturing and service systems (e.g., throughput, measurement, automation, line balancing, energy management)
C. Forecasting (e.g., moving average, exponential smoothing, tracking signals)
D. Planning and scheduling (e.g., inventory, aggregate planning, MRP, theory of constraints, sequencing)
E. Process improvements (e.g., lean systems, sustainability, value engineering)

9. Facilities and Supply Chain **9–14**

A. Flow, layout, and location analysis (e.g., from/to charts, layout types, distance metrics)
B. Capacity analysis (e.g., number of machines and people, trade-offs, material handling)
C. Supply chain management and design (e.g., pooling, transportation, network design, single-level/multilevel distribution models)

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

A. Human factors (e.g., displays, controls, usability, cognitive engineering)
B. Safety and industrial hygiene (e.g., workplace hazards, safety programs, regulations, environmental hazards)
C. Ergonomics (e.g., biomechanics, cumulative trauma disorders, anthropometry, workplace design, macroergonomics)

11. Work Design **7–11**

A. Methods analysis (e.g., charting, workstation design, motion economy)
B. Work measurement (e.g., time study, predetermined time systems, work sampling, standards)
C. Learning curves

12. Quality **9–14**

A. Quality management, planning, assurance, and systems (e.g., Six Sigma, QFD, TQM, house of quality, fishbone, Taguchi loss function)
B. Quality control (e.g., control charts, process capability, sampling plans, OC curves, DOE)

13. Systems Engineering, Analysis, and Design **8–12**

A. Requirements analysis and system design
B. Functional analysis and configuration management
C. Risk management (e.g., FMEA, fault trees, uncertainty)
D. Life-cycle engineering
E. Reliability engineering (e.g., MTTF, MTBR, availability, parallel and series failure)

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Fundamentals of Engineering (FE)
MECHANICAL CBT Exam Specifications

Effective Beginning with the July 2020 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 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 U.S. Customary System (USCS).

Knowledge	Number of Questions
1. Mathematics	**6–9**
A. Analytic geometry	
B. Calculus (e.g., differential, integral, single-variable, multivariable)	
C. Ordinary differential equations (e.g., homogeneous, nonhomogeneous, Laplace transforms)	
D. Linear algebra (e.g., matrix operations, vector analysis)	
E. Numerical methods (e.g., approximations, precision limits, error propagation, Taylor's series, Newton's method)	
F. Algorithm and logic development (e.g., flowcharts, pseudocode)	
2. Probability and Statistics	**4–6**
A. Probability distributions (e.g., normal, binomial, empirical, discrete, continuous)	
B. Measures of central tendencies and dispersions (e.g., mean, mode, standard deviation, confidence intervals)	
C. Expected value (weighted average) in decision making	
D. Regression (linear, multiple), curve fitting, and goodness of fit (e.g., correlation coefficient, least squares)	
3. Ethics and Professional Practice	**4–6**
A. Codes of ethics (e.g., NCEES *Model Law*, professional and technical societies, ethical and legal considerations)	
B. Public health, safety, and welfare	
C. Intellectual property (e.g., copyright, trade secrets, patents, trademarks)	
D. Societal considerations (e.g., economic, sustainability, life-cycle analysis, environmental)	
4. Engineering Economics	**4–6**
A. Time value of money (e.g., equivalence, present worth, equivalent annual worth, future worth, rate of return, annuities)	
B. Cost types and breakdowns (e.g., fixed, variable, incremental, average, sunk)	
C. Economic analyses (e.g., cost-benefit, break-even, minimum cost, overhead, life cycle)	

5. Electricity and Magnetism **5–8**

A. Electrical fundamentals (e.g., charge, current, voltage, resistance, power, energy, magnetic flux)
B. DC circuit analysis (e.g., Kirchhoff's laws, Ohm's law, series, parallel)
C. AC circuit analysis (e.g., resistors, capacitors, inductors)
D. Motors and generators

6. Statics **9–14**

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

7. Dynamics, Kinematics, and Vibrations **10–15**

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

8. Mechanics of Materials **9–14**

A. Shear and moment diagrams
B. Stress transformations and Mohr's circle
C. Stress and strain caused by axial loads
D. Stress and strain caused by bending loads
E. Stress and strain caused by torsional loads
F. Stress and strain caused by shear
G. Stress and strain caused by temperature changes
H. Combined loading
I. Deformations
J. Column buckling
K. Statically indeterminate systems

9. Material Properties and Processing **7–11**

A. Properties (e.g., chemical, electrical, mechanical, physical, thermal)
B. Stress-strain diagrams
C. Ferrous metals
D. Nonferrous metals
E. Engineered materials (e.g., composites, polymers)
F. Manufacturing processes
G. Phase diagrams, phase transformation, and heat treating
H. Materials selection
I. Corrosion mechanisms and control
J. Failure mechanisms (e.g., thermal failure, fatigue, fracture, creep)

10. Fluid Mechanics **10–15**

A. Fluid properties
B. Fluid statics
C. Energy, impulse, and momentum
D. Internal flow
E. External flow
F. Compressible flow (e.g., Mach number, isentropic flow relationships, normal shock)
G. Power and efficiency
H. Performance curves
I. Scaling laws for fans, pumps, and compressors

11. Thermodynamics **10–15**

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

12. Heat Transfer **7–11**

A. Conduction
B. Convection
C. Radiation
D. Transient processes
E. Heat exchangers

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

A. Sensors and transducers
B. Control systems (e.g., feedback, block diagrams)
C. Dynamic system response
D. Measurement uncertainty (e.g., error propagation, accuracy, precision, significant figures)

14. Mechanical Design and Analysis **10–15**

A. Stress analysis of machine elements
B. Failure theories and analysis
C. Deformation and stiffness
D. Springs
E. Pressure vessels and piping
F. Bearings
G. Power screws
H. Power transmission
I. Joining methods (e.g., welding, adhesives, mechanical fasteners)
J. Manufacturability (e.g., limits, fits)
K. Quality and reliability
L. Components (e.g., hydraulic, pneumatic, electromechanical)
M. Engineering drawing interpretations and geometric dimensioning and tolerancing (GD&T)

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Fundamentals of Engineering (FE)
OTHER DISCIPLINES CBT Exam Specifications

Effective Beginning with the July 2020 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 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 U.S. Customary System (USCS).

Knowledge	Number of Questions
1. Mathematics	**8–12**
A. Analytic geometry and trigonometry	
B. Differential equations	
C. Numerical methods (e.g., algebraic equations, roots of equations, approximations, precision limits, convergence)	
D. Linear algebra (e.g., matrix operations)	
E. Single-variable calculus	
2. Probability and Statistics	**6–9**
A. Estimation (e.g., point, confidence intervals)	
B. Expected value and expected error in decision making	
C. Sample distributions and sizes (e.g., significance, hypothesis testing, non-normal distributions)	
D. Goodness of fit (e.g., correlation coefficient, standard errors, R^2)	
3. Chemistry	**5–8**
A. Oxidation and reduction (e.g., reactions, corrosion control)	
B. Acids and bases (e.g., pH, buffers)	
C. Chemical reactions (e.g., stoichiometry, equilibrium, bioconversion)	
4. Instrumentation and Controls	**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, signal processing, analog/digital [A/D], digital/analog [D/A], digital)	
C. Logic diagrams	
5. Engineering Ethics and Societal Impacts	**5–8**
A. Codes of ethics (e.g., identifying and solving ethical dilemmas)	
B. Public protection issues (e.g., licensing boards)	
C. Societal impacts (e.g., economic, sustainability, life-cycle analysis, environmental, public safety)	

6. Safety, Health, and Environment **6–9**

A. Industrial hygiene (e.g., carcinogens, toxicology, exposure limits, radiation exposure, biohazards, half-life)
B. Basic safety equipment (e.g., pressure-relief valves, emergency shutoffs, 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
E. Confined space entry and ventilation rates
F. Hazard communications (e.g., SDS, proper labeling, concentrations, fire ratings, safety equipment)

7. Engineering Economics **6–9**

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

8. Statics **9–14**

A. Vector analysis
B. Force systems (e.g., resultants, concurrent, distributed)
C. Force couple systems
D. Equilibrium of rigid bodies (e.g., support reactions)
E. Internal forces in rigid bodies (e.g., trusses, frames, machines)
F. Area properties (e.g., centroids, moments of inertia, radius of gyration, parallel axis theorem)
G. Static friction
H. Free-body diagrams
I. Weight and mass computations (e.g., slug, lb_m, lb_f, kg, N, ton, dyne, g, g_c)

9. Dynamics **9–14**

A. Particle and rigid-body 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 (e.g., linear, angular)
F. Work, energy, and power
G. Dynamic friction
H. Vibrations (e.g., natural frequency)

10. Strength of Materials **9–14**

A. Stress types (e.g., normal, shear)
B. Combined loading–principle of superposition
C. Stress and strain caused by axial loads, bending loads, torsion, or transverse shear forces
D. Shear and moment diagrams
E. Analysis of beams, trusses, frames, and columns
F. Loads and deformations (e.g., axial-extension, torque-angle of twist, moment-rotation)

G. Stress transformation and principal stresses, including stress-based yielding and fracture criteria (e.g., Mohr's circle, maximum normal stress, Tresca, von Mises)
H. Material failure (e.g., Euler buckling, creep, fatigue, brittle fracture, stress concentration factors, factor of safety, and allowable stress)

11. Materials **6–9**

A. Physical (phase diagrams) properties of materials (e.g., alloy phase diagrams, phase equilibrium, and phase change)
B. Mechanical properties of materials
C. Chemical properties of materials
D. Thermal properties of materials
E. Electrical properties of materials
F. Material selection

12. Fluid Mechanics **12–18**

A. Fluid properties (e.g., Newtonian, non-Newtonian, liquids and gases)
B. Dimensionless numbers (e.g., Reynolds number, Froude number, Mach number)
C. Laminar and turbulent flow
D. Fluid statics (e.g., hydrostatic head)
E. Energy, impulse, and momentum equations (e.g., Bernoulli equation)
F. Pipe and duct flow and friction losses (e.g., pipes, valves, fittings, laminar, transitional and turbulent flow)
G. Open-channel flow (e.g., Manning's equation, drag)
H. Fluid transport systems (e.g., series and parallel operations)
I. Flow measurement (e.g., pitot tube, venturi meter, weir)
J. Turbomachinery (e.g., pumps, turbines, fans, compressors)
K. Ideal gas law (e.g., mixtures of nonreactive gases)
L. Real gas law (e.g., z factor)

13. Basic Electrical Engineering **6–9**

A. Electrical fundamentals (e.g., charge, current, voltage, resistance, power, energy)
B. Current and voltage laws (e.g., Kirchhoff, Ohm)
C. AC and DC circuits (e.g., real and imaginary components, complex numbers, power factor, reactance and impedance, series, parallel, capacitance and inductance, RLC circuits)
D. Measuring devices (e.g., voltmeter, ammeter, wattmeter)
E. Three-phase power (e.g., motor efficiency, balanced loads, power equation)

14. Thermodynamics and Heat Transfer **9–14**

A. Thermodynamic laws (e.g., first law, second law)
B. Thermodynamic equilibrium
C. Thermodynamic properties (e.g., entropy, enthalpy, heat capacity)
D. Thermodynamic processes (e.g., isothermal, adiabatic, reversible, irreversible)
E. Heat transfer (e.g., conduction, convection, radiation)
F. Mass and energy balances
G. Property and phase diagrams (e.g., T-s, P-h, P-v)
H. Combustion and combustion products (e.g., CO, CO_2, NO_X, ash, particulates)
I. Psychrometrics (e.g., relative humidity, wet bulb)