NCEES
advancing licensure for engineers and surveyors

Fundamentals of Engineering (FE)
CHEMICAL 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 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	**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 SDS
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)