

**Principles and Practice of Engineering Examination
 MECHANICAL—MACHINE DESIGN AND MATERIALS Exam Specifications**

Effective Beginning with the April 2017 Examinations

- The exam is an 8-hour open-book exam. It contains 40 multiple-choice questions in the 4-hour morning session, and 40 multiple-choice questions in the 4-hour afternoon session. Examinee works all questions.
- The exam uses both the International System of units (SI) and the U.S. Customary System (USCS).
- The exam is developed with questions that will require a variety of approaches and methodologies, including design, analysis, and application.
- The knowledge areas specified as examples of kinds of knowledge are not exclusive or exhaustive categories.

	Approximate Number of Questions
I. Principles	40
A. Basic Engineering Practice	9
1. Engineering terms, symbols	
2. Interpretation of technical drawings	
3. Quality assurance/quality control (QA/QC)	
4. Project management and economic analysis	
5. Units and conversions	
6. Design methodology (e.g., identifying requirements, risk assessment, verification/validation)	
B. Engineering Science and Mechanics	10
1. Statics	
2. Kinematics	
3. Dynamics	
C. Material Properties	8
1. Physical (e.g., density, melting point, optical)	
2. Chemical (e.g., corrosion, alloys, oxidation)	
3. Mechanical	
a. Time-independent behavior (e.g., modulus, hardness, thermal expansion)	
b. Time-dependent behavior (e.g., creep, viscoelastic, thermal conductivity)	
D. Strength of Materials	10
1. Stress/strain (e.g., tension, compression)	
2. Shear	
3. Bending	
4. Buckling	
5. Torsion	

6. Fatigue	
7. Failure theories (e.g., Von Mises, maximum shear stress)	
E. Vibration	3
1. Natural frequencies (e.g., linear, bending, torsional) and acoustics	
2. Damping (e.g., frequency, damping ratio, critical damping)	
3. Forced vibrations (e.g., magnification factor, transmissibility, balancing, isolation)	
II. Applications	40
A. Mechanical Components	18
1. Pressure vessels and piping (e.g., thick/thin wall)	
2. Bearings (e.g., types, lubrication analysis, life-load analysis)	
3. Gears (e.g., types, speed analysis, force analysis)	
4. Springs (e.g., types, force analysis, fatigue analysis)	
5. Dampers (e.g., types, selection)	
6. Belt, pulley and chain drives (e.g., types, force analysis)	
7. Clutches and brakes (e.g., types, torque/force analysis)	
8. Power screws (e.g., types, lifting and lowering torque, locking conditions)	
9. Shafts and keys (e.g., torsion, bending, static/fatigue failure, stress risers)	
10. Mechanisms (e.g., linkages, cams, slider crank, levers, force analysis, kinetic analysis)	
11. Basic mechatronics (e.g., electromechanical interfaces, sensors, basic circuits, basic controls)	
12. Hydraulic and pneumatic components (e.g., pumps, cylinders, presses)	
13. Motors and engines (e.g., energy conservation, efficiency)	
B. Joints and Fasteners	12
1. Welding and brazing (e.g., types, symbols, stress analysis)	
2. Bolts, screws, rivets (e.g., grade/class selection, preload, fastener group force analysis)	
3. Adhesives (e.g., types, analysis)	
C. Supportive Knowledge	10
1. Manufacturing processes (e.g., machining, molding, heat treatment)	
2. Fits and tolerances	
3. Codes and standards	
4. Computational methods and their limitations (e.g., FEA, CAE)	
5. Testing and instrumentation	