

Massachusetts Tests for Educator Licensure® (MTEL®)

FIELD 33: TECHNOLOGY/ENGINEERING TEST OBJECTIVES

Subarea	Multiple-Choice	Range of Objectives	Approximate Test Weighting
I.	Foundations and Engineering Design	01–04	16%
II.	Energy and Power Systems	05–08	15%
III.	Construction Technologies	09–10	13%
IV.	Manufacturing Technologies	11–13	13%
V.	Communication Technologies	14–16	13%
VI.	Transportation Technologies	17–18	<u>10%</u>
			80%
	Open-Response		
VII.	Integration of Knowledge and Understanding	19	20%

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Massachusetts Tests for Educator Licensure® (MTEL®)
Test Objectives
Field 33: Technology/Engineering

SUBAREAS:

FOUNDATIONS AND ENGINEERING DESIGN
ENERGY AND POWER SYSTEMS
CONSTRUCTION TECHNOLOGIES
MANUFACTURING TECHNOLOGIES
COMMUNICATION TECHNOLOGIES
TRANSPORTATION TECHNOLOGIES

FOUNDATIONS AND ENGINEERING DESIGN [16%]

0001 Understand the historical and social contexts of technology/engineering.

For example:

- Identify historical events and developments related to the evolution of technology/engineering (i.e., Stone Age to Information Age) and examples of technological innovations that led to the transition from one age to the next.
- Demonstrate knowledge of the role of technology/engineering in society and in global economics.
- Demonstrate knowledge of positive and negative effects of technology/engineering (e.g., nuclear energy; pesticides; fossil fuels; use of transportation, communication, construction, and medical technologies).
- Analyze technological claims in the media.

0002 Understand the connections among engineering, technology, mathematics, and natural science.

For example:

- Apply knowledge of mathematical principles and concepts (e.g., ratios, dimensional analysis, graphing, linear and quadratic equations, trigonometric functions) to technological situations.
- Apply measurement concepts (e.g., accuracy, precision, significant figures, scientific notation, unit conversion) in various situations.
- Apply knowledge of natural sciences to technological situations.
- Demonstrate knowledge of engineering terminology.

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0003 Understand engineering design and the role of modeling and optimizing in developing technological solutions to problems within given constraints.

For example:

- Describe the steps of the Engineering Design Process and analyze their role in various applications.
- Analyze technology systems according to the Universal Systems Model (i.e., goal, inputs, processes, outputs, feedback).
- Demonstrate knowledge of the role of models and prototypes in the optimization of solutions to design/build issues.
- Analyze design features (e.g., size, shape, weight, function, cost limitations) when developing technological solutions to problems.
- Interpret plans, diagrams, and working drawings and other methods of representing solutions to design problems.
- Demonstrate knowledge of pictorial and multiview drawings (e.g., orthographic, isometric, oblique, perspective).
- Solve problems involving scale and proportion in technical drawings.

0004 Understand the selection and safe use of appropriate materials, tools, equipment, and machines in technology/engineering.

For example:

- Demonstrate knowledge of rules and guidelines related to the safe use of tools and machines.
- Demonstrate knowledge of appropriate procedures for dealing with accidents and injuries in the technology/engineering laboratory.
- Identify appropriate materials for a given task based on their types and properties and the hazards associated with given materials.
- Apply skills needed to select and use appropriate measuring tools (e.g., rigid rule, micrometer, caliper, square) for finding linear measurements, diameters, and angles.
- Apply skills needed to select and use appropriate hand and power tools (e.g., shaping, cutting, boring, gripping, joining, fastening).

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ENERGY AND POWER SYSTEMS [15%]

0005 Understand fluid systems and their role in technology systems.

For example:

- Identify types of fluid systems (e.g., open, closed, hydraulic, pneumatic) and their characteristics and uses.
- Identify characteristics of open and closed systems (e.g., humidity control systems, heating systems, cooling systems) and their uses.
- Identify the components of fluid systems (e.g., fluid, valves, metering devices, controlling devices, pumps).
- Demonstrate knowledge of Bernoulli's principle in technology/engineering applications (e.g., airfoil design, building design).
- Analyze factors affecting resistance in fluid systems (e.g., types of pipe, changes in pipe diameter, elbows and connectors).
- Solve problems related to hydraulic systems and hydrostatic pressure and depth in fluid systems.

0006 Understand thermal systems and their role in technology systems.

For example:

- Apply knowledge of the first law of thermodynamics (conservation of energy).
- Describe processes by which heat is transferred (i.e., radiation, convection, conduction) and the role of these processes in technology systems.
- Identify controls and characteristics of components of thermal systems (e.g., thermostats, temperature sensors, heat pumps) and their role in thermal systems.
- Demonstrate knowledge of processes affecting the heating and cooling of spaces, including the effect of environmental conditions.
- Analyze alternatives to nonrenewable thermal energy sources (e.g., biofuels, geothermal, solar thermal).

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0007 Understand electrical principles and components and their roles in technology systems.

For example:

- Demonstrate knowledge of the nature of electricity and electromagnetic forces.
- Demonstrate knowledge of processes and equipment for generating AC and DC current and the role of AC and DC current in technology systems.
- Identify types, functions, and schematic representations of components (e.g., source, conductor, load, resistor, diode, transistor, generator, switch, relay, integrated circuit) of electrical systems.
- Apply procedures for measuring and calculating voltage, resistance, current, and power in electric circuits.
- Solve problems involving voltage, resistance, current, and power in series and parallel circuits using Ohm's law.
- Analyze factors that affect the resistance of a conductor.
- Demonstrate knowledge of alternative technologies for producing electrical energy (e.g., fuel cells, wind turbines, solar cells, hydropower).

0008 Understand basic principles of energy, work, and power and their relationship to mechanical systems.

For example:

- Apply Newton's laws of motion to mechanical systems.
- Demonstrate knowledge of the concepts of energy, work, and power and their interrelationships.
- Solve problems involving force, mechanical advantage, and simple machines in mechanical systems (e.g., gear ratios, hydraulic systems, levers).
- Demonstrate knowledge of devices and processes used to transmit power in mechanical systems (e.g., gears, pulleys, transmissions, differentials).

**Field 33: Technology/Engineering
Test Objectives**

CONSTRUCTION TECHNOLOGIES [13%]

0009 Understand design factors, material selection, and constraints in building structures.

For example:

- Demonstrate knowledge of the functions of components (e.g., foundation, flooring, decking, walls, roofing systems) that make up engineered buildings.
- Demonstrate knowledge of types of bridges (e.g., arch, beam, suspension, truss) and factors affecting their appropriate uses (e.g., site, span, resources, loads).
- Demonstrate knowledge of the considerations and constraints affecting selection of materials in construction technology (e.g., elasticity, plasticity, thermal conductivity, density, cost, geographic location).
- Demonstrate knowledge of the purpose of building codes and zoning laws.

0010 Understand the effects of forces in construction technology.

For example:

- Analyze how the forces of tension, compression, torsion, bending, and shear affect the performance of structures.
- Analyze how different structural shapes will perform under various loads.
- Demonstrate knowledge of the resultant forces for various loads (e.g., live, dead, combined, wind, snow).

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MANUFACTURING TECHNOLOGIES [13%]

0011 Understand primary and secondary manufacturing processes used to create manufactured products.

For example:

- Identify primary manufacturing processes (e.g., mechanical, thermal, chemical, electrochemical) used to extract and collect raw materials and to prepare these materials for manufacturing.
- Identify sources of raw materials and methods used to extract or collect the raw materials.
- Describe secondary manufacturing processes (e.g., casting and molding, forming, separating, conditioning, assembling, finishing).
- Identify types and characteristics of machines used to change the form of materials in technology/engineering systems.
- Demonstrate knowledge of the role of automation and robotics in manufacturing.
- Analyze how interchangeable parts and mass production have affected manufacturing technologies and manufactured products.

0012 Understand how manufacturing enterprises and facilities are structured and managed.

For example:

- Demonstrate knowledge of how manufacturing organizations are structured (e.g., organizational charts; roles of research and development, marketing, production, and quality control) and managed (e.g., factors affecting profit margins, efficient use of resources, cost-benefit analyses).
- Analyze custom and mass-production manufacturing systems (e.g., just-in-time manufacturing, lean manufacturing, total quality management) and their uses.
- Demonstrate knowledge of procedures for ensuring quality control and meeting design criteria and constraints in a manufacturing system.
- Analyze manufacturing systems to determine the proper processes, tools, materials, and sequences of tasks for a given manufacturing task.

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0013 Understand bioengineering technologies.

For example:

- Demonstrate a general knowledge of the role of bioengineering in agriculture, food-processing, medicine, and health technologies.
- Demonstrate a general knowledge of bioengineered products (e.g., foods, biofuels, irradiation, integrated pest management, assistive devices).

COMMUNICATION TECHNOLOGIES [13%]

0014 Understand processes used to communicate messages and ideas.

For example:

- Analyze communication systems, their components (e.g., source, encoder, transmitter, receiver, decoder, storage, retrieval, destination), and the relationships among the components.
- Analyze the benefits and limitations of different communication systems (e.g., audio, visual, printed, networked, multimedia).
- Demonstrate knowledge of how information travels through different media (e.g., electrical wire, optical fiber, air, space).
- Differentiate between digital and analog signals.

0015 Understand waves, wave motion, and the basic principles of acoustics.

For example:

- Describe the properties of sound waves (e.g., amplitude, frequency, harmonics) and how they relate to the perception of sound (e.g., pitch, intensity, timbre).
- Describe factors that affect the propagation of sound in different media.
- Demonstrate knowledge of the Doppler effect and of wave interactions (e.g., harmonics, resonance, overtones).
- Solve problems involving waves and wave motion.

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0016 Understand the nature of light and its application to communication technology.

For example:

- Identify the characteristics of light (e.g., wave, particle, reflection, refraction, additive and subtractive color theory) and their application in communication (e.g., photography, desktop publishing, multimedia).
- Analyze the applications of laser and fiber-optic technologies (e.g., telephone systems, cable television, DVDs, desktop printers).
- Demonstrate knowledge of the electromagnetic spectrum and its application in communication technology.

TRANSPORTATION TECHNOLOGIES [10%]

0017 Understand the principles and characteristics of transportation technology.

For example:

- Identify types of transportation systems (e.g., land, water, air, space, intermodal) and their characteristics.
- Identify types and characteristics of power sources (e.g., gasoline, diesel, solar, wind, electrical) used in transportation systems.
- Analyze the effects of lift, drag, friction, thrust, and gravity on transportation systems.

0018 Understand processes and devices used in transportation technologies.

For example:

- Demonstrate knowledge of subsystems (e.g., structural, propulsion, guidance, suspension, control, support) of transportation systems and their functions.
- Demonstrate knowledge of safety in transportation systems (e.g., seat belts, crush zones, helmets).

**Field 33: Technology/Engineering
Test Objectives**

INTEGRATION OF KNOWLEDGE AND UNDERSTANDING [20%]

In addition to answering multiple-choice items, candidates will prepare written responses to questions addressing content summarized in the objective below.

- 0019 Prepare an organized, developed analysis on a topic related to one or more of the following: the design process and its relationship to models and technical drawings and technical processes in the areas of energy and power, construction, manufacturing, communication, or transportation.**

(Refer to objectives 0001 through 0018 and associated descriptive statements.)