

Massachusetts Technical Teacher Testing Program Engineering Technology Content Outline

Written and Performance Exam General Overview

- The intent of this exam is to assess your ability to teach the skills found in the Massachusetts Technical Education Framework.
- This exam is aligned to the frameworks which can be accessed [here](#).
- Many questions and tasks require a synthesis of knowledge based on experience in the field and may not be found in any book.
- Candidates are encouraged to prepare for their exam by reviewing textbooks and reference material which has been listed as part of this exam outline. These resources can be found using online search tools, online vendors, and websites.
- Contact the Technical Teacher Testing Office if you need further assistance in locating resources listed in the exam outline.
- Use this exam outline and the Massachusetts Technical Education Framework to focus your preparation for the exam.

Written Exam

- Number of Questions: 100
- Administration Time: 3 hours
- Administration Method: Remote Proctoring Online Session

Written Exam Content Coverage

10% **Automated System Engineering**

- | | |
|---|--|
| <ul style="list-style-type: none"> • Concepts • Design Implementation • The major and minor axes of a robotic arm • Robotic grippers and work envelopes | <ul style="list-style-type: none"> • Sensors • Basic Elements of a Computer Integrated Manufacturing (CIM) Station |
|---|--|

10% **Electrical Engineering**

- | | |
|---|--|
| <ul style="list-style-type: none"> • Concepts • Analyze series and parallel resistive circuits • Basic digital logic (INV, AND & OR gates) | <ul style="list-style-type: none"> • Analyze and extract information from a truth table • Convert binary and Hexadecimal Notation • Ohm's Law and Related Calculation |
|---|--|

15% Engineering Mathematics

- Physics Problems
- Calculate problems related to Civil and General Engineering
- Apply basic algebra, trigonometry and geometry principles
- Basic properties of materials
- Apply the Reynolds number and Pascal's Law
- Degrees and Rads

36% Engineering Fundamentals

- Design Process
- Problem Solving, Diagnostics
- Documentation and Communication Concepts
- Product Objectives and Criteria
- Production, Planning and Methods
- Manufacturing Process
- Mode, Mean and Median
- Basic instruments in Temperature, Fluid and Pressure regulation
- Open and closed loop principles
- Engineering journals, notebooks and written reports
- Application of drawing views (i.e. front, side views)
- Tools, Terminology and Applications of Total Quality Management (TQM)
- Basic Statistics
- General CAD Concepts

4% Engineering Health & Safety

- Basic Application of the SDS

10% Mechanical Engineering

- Physics of Mechanical Systems
- Materials
- Simple Machine Concepts and Applications
- Fluid System Concepts and Pascal's Law
- Heat Flow Systems and Control Devices
- Solve Related Calculations
- Apply various machining techniques
- Apply basic manufacturing techniques
- Process Control (Six Sigma Defects per Unit)
- Elements of
 - Gear Trains
 - Turbofan Engines
 - Turbojet Engines
 - Rocker Arms
- Linear and Rotational Mechanical Systems
- Basic Rapid Prototyping Concept
- General Gas Laws

5% Engineering Related Science

- Newton's 3 Laws of Motion
- Energy, Work and Power
- Thermal Systems and Properties
- Electrical Systems and Properties, Ohm's Law Applications
- Fluid Systems
- Materials and Ceramics
- Calculate basic one-dimensional kinematics
- Fundamentals of Physics

10% Civil and Architectural Engineering Concepts

- Importance of Civil and Architectural Engineering
- Components of and Coordination Required for an Entire Construction Document
- Structural Systems
- Surveying Equipment and Strategies
- Free-body Diagrams
- Site Surveys
- Conduct Soil Testing and Analyze Results
- Analyze Site and Determine the Drainage Requirements
- Dead, Live and Environmental Loads on a Structure
- Tributary Area of Structural Elements
- Architectural Styles
- As-build Drawings

Written Exam Reference Materials (Reference Current Edition)

- **Digital Fundamentals** by Thomas Floyd (Prentice Hall)
- **Electricity & Electronics** by H.H. Gerrish, W.E. Dugger, Jr. and R.M. Roberts (Goodheart-Willcox)
- **The Science and Engineering of Materials** by Donald Askeland PWS Publishing Company
- **Industrial Robotics and Automation** by A.K. Gupta (Mercury Learning & Information)
- **Instrumentation and Process Control** by Terry L. M. Bartelt (Cengage Learning)
- **Basic Physics: A Self Teaching Guide** by Karl Kuhn (Wiley)
- **Introduction to Statistical Quality Control** by Douglas C. Montgomery (John Wiley & Sons, Inc.)
- **Introduction to Engineering** by Paul H. Wright (John Wiley & Sons Inc.)
- **Instrumentation** by Franklyn W. Kirk and Nicholas R. Rimboi (American Technical Publishing)
- **Internet Resources:**
 - Math (Algebra): www.khanacademy.org
 - Physics Equations: <http://physics.info/equations/>
 - Basic Physics Tutorial: <http://gbhsweb.glenbrook225.org/gbs/science/phys/class/bboard.html>
 - Robotic Arm info and links: http://en.wikipedia.org/wiki/Robotic_arm
 - Industrial Robot info and links: http://en.wikipedia.org/wiki/Industrial_robot
 - Statistical Quality Control (Chp. 6): <http://www.wiley.com/college/sc/reid/chap6.pdf>
 - Science and Engineering of Materials: <http://ocw.mit.edu/courses/materials-science-and-engineering/>
 - Basic Logic Gates: http://en.wikipedia.org/wiki/Logic_gate
 - Ohm's Law: http://www.allaboutcircuits.com/vol_1/chpt_5/6.html
 - Boolean Algebra Rules: <http://www.uotechnology.edu.iq/dep-eee/lectures/1st/Digital%20techniques/part2.pdf>
 - Civil and Architectural Engineering:
 - <https://www.indiabix.com/civil-engineering/questions-and-answers/>
 - <https://engineeringmcqs.blogspot.in/2014/07/civil-engineering-questions-and-answers.html>

Reference Materials as stated in the Engineering Technology Frameworks by the DESE

- **Digital Fundamentals** by T.L. Floyd (Pearson: Prentice Hall)
- **Digital Electronics: Principles and Applications** by Roger Tokheim (McGraw Hill)
- **Foundations of Engineering** by Mark T. Holtzapple (McGraw Hill)

- **Civil Engineering Reference Manual for the PE Exam** by M.R. Lindeburg (Professional Publications, Inc.)
- **Civil Engineering and Architecture** by Donna Matteson, Deborah Kennedy, Stuart Baur, Eva Kultermann (Cengage Learning)
- **Revit Architecture** by Paul F. Aubin (Cengage Learning)
- **Engineering Drawing and Design** by David A. Madsen and David P. Madsen (Delmar: Thomson Learning)
- **Engineering Design: An Introduction** by John R. Karsnitz, Stephen O'Brien, and John P. Hutchinson (Delmar: Cengage Learning)
- **Principles of Engineering** by Brent Handley, Craig Coon, and David M. Marshall (Delmar: Cengage Learning)

Materials Needed for the Written Exam

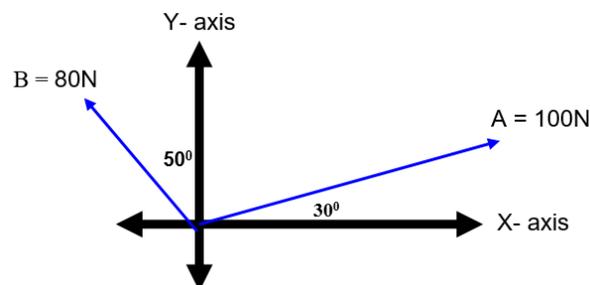
- A four-function calculator is included in the online testing system. No other calculators are permitted.
- Scrap paper and pencil/pen are permitted.

Written Exam Sample Items

Each question on the exam consists of one incomplete sentence or question followed by four choices. Some items reference an image or diagram. A few sample items are included below; the correct answer is designated with an asterisk (*).

When is a fire watch needed?

Given vector A of 100 N and vector B of 80 N as shown in the diagram below, find the magnitude and direction of the resultant vector.



- *a. 105 N at 76° North of the X-axis
- b. 105 N at 140° North of the X-axis
- c. 178 N at 76° North of the X-axis
- d. 178 N at 140° North of the X-axis

Convert Binary number 001001011011 to HEX

- a. 20C
- *b. 25B
- c. 97D
- d. 125A

A ball is dropped from a height of 5m to the ground. How long is the ball in the air? What is the velocity of the ball just before impact with the ground?

- a. 0.50 sec and 4.37 m/s
- *b. 1.01 sec and 9.90 m/s
- c. 1.54 sec and 12.13 m/s
- d. 2.02 sec and 14.40 m/s

Reduce the Boolean Expression: $AB'C + AB'C + ABC$

- a. AB'
- *b. AC
- c. AB
- d. $B'C$

Performance Exam

- Administration Time: 4 hours
- Administration Method: Onsite at an approved Teacher Testing Location

Performance Exam Content Coverage

Note: Candidates must complete Subtest 1: Reverse Engineering and Subtest 6: Safety and choose any two of the following 4 subtests (2 through 5). Candidate must notify the testing vendor (NOCTI) no later than two weeks prior to the exam date to indicate which TWO subtest areas you wish to participate in.

35% Subtest 1: Reverse Engineering

- Prepare a Technical Presentation Board for Given Disassembled Device
- Initiate Improvements on an Existing Device
- Communicate Through Sketching
- Articulate Functionality and Benefits of Improvements

30 % Subtest 2: Digital Electronics

- Develop Boolean Expressions
- Simplify Boolean Expressions
- Generate Boolean Circuits
- Breadboard and Test Circuits

30% Subtest 3: Machining and Stress Analysis

- Manually Machine a Part according to Given Specifications using a Lathe and
- Vertical Mill
- Perform a Stress Analysis on a Given Part using Structural Analyzer 1000, by Advanced Manufacturing Techniques, Inc.

30% Subtest 4: Technical Drafting - CADD

- Create a CAD Drawing of a Given Part**
- Create a Three-dimensional Model using Appropriate Computer Software

Note: If you will be participating in Subtest 4: Technical Drafting – CADD subtest, you will be allowed the use of your personal computer for this Subtest ONLY. If you plan to bring your own personal computer with loaded CADD software, you need to inform the testing center. **Inventor CADD Software will be available for completion of Subtest 4: Technical Drafting-CADD provided you do not bring your own computer with CADD software already loaded.

30% Subtest 5: Industrial Robotics and Automation

- Identify and Hard-Wire Sensors**
- Prepare a Robotic/Automation Workcell for Programming

****Note:** For the Industrial Robotics and Automation (subtest 5), a Scorbot IV Robotic Workcell will be utilized. Other Robotic manipulators and related peripherals could be considered upon request from the candidates. Candidates interested on making arrangements for using alternate systems must notify the testing vendor (NOCTI) no later than 2 weeks prior to the exam date to indicate their choice.

5% Safety

- Use appropriate PPE
- Demonstrate safety practices throughout procedures
- Safely use tools according to manufacturer's specifications
- Use and dispose of chemicals and biohazardous materials
- Leave work area clean and according to industry and OSHA standards

Materials Required for the Performance Exam (Candidate Must Supply)

- Face mask (cotton face covering or respirator which fully cover the nose and mouth)
- Eye Protection
- Disposable Gloves
- Calculator
- Pens/Pencils

Note: Additional materials, equipment, and supplies will be provided. No books or notes will be allowed. Cell phones are prohibited during the exam administration.

Onsite Performance Exam Requirements

- Candidate must practice social distancing and wear the appropriate face covering that covers the nose and mouth while at the exam site.
- Testing sites may have individual requirements based on location and the current guidance from the Center for Disease Control and Prevention (CDC).

Performance Exam Reference Materials (Reference Current Edition)

- **Digital Fundamentals** by T.L. Floyd (Pearson: Prentice Hall)
- **Industrial Robotics and Automation** by A.K. Gupta (Mercury Learning & Information)
- **Instrumentation** by Franklyn W. Kirk and Nicholas R. Rimboi (American Technical Publishers, Inc)
- **Instrumentation and Process Control** by Terry L. M. Bartelt (Cengage Learning)
- **Machining** Suggested Resources
 - <https://detroitmachine.tools/machining-help/machining-handbook>
 - <http://collections.infocollections.org/ukedu/en/d/jgtz097be/5.html>
 - VIDEO: <https://www.youtube.com/watch?v=SOOnPEwP9bCA>
- **Safety Orientation** by NCCER (Pearson Prentice Hall) www.crafttraining.com
- **OSHA Regulations** www.osha.gov
 - [1910.1200 - Hazard Communication](#)
 - [1910 Subpart I - Personal Protective Equipment](#)