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### 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

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**3% Fundamentals of Health and Safety**

- Health and Safety Practices

**5% Tools and Instruments**

- Use of Tools, Fasteners, and Equipment
- Use of Electronics Hand Tools and Equipment
- Use of Electrical Test Equipment

**8% Engineering Design Process**

- Components of Design Process

**10% Technical Communications**

- Various Types of Written Technical Communications
- Visual Communications Within the Electrical and Electronics Fields
- Flowcharts
- Hand Sketch Drawings
- CAD System

- 12% Mechanical Concepts**
- Mechanical Transfer System
  - IMA, AMA, and Efficiency
  - Simple Versus Compound Machines
  - Hydraulic System
  - Mechanical System
  - Pneumatic System
- 15% Electrical Concepts**
- Basic Electronic Components
  - Test Basic Electric Circuits
  - Magnetic Devices
  - AC Circuits
  - Diodes and Transistors
  - Digital Logic Circuits
  - Electric Power Transmission and Distributor
  - Convert Integers with Binary, HEX, and Decimal Number Systems
- 12% Fundamentals of Sensor Technology**
- Position Sensors
  - Velocity Sensors
  - Proximity Sensors
  - Load and Force Sensors
  - Pressure Sensors
  - Temperature Sensors
- 17% Programmable Logic Controllers (PLCs)**
- Basic Building Blocks of a PLC
  - PLC Hardware Components
  - PLC Logic
  - PLC Programs and PLC Wiring Diagrams
- 14% Robotics Technology**
- Basic Building Blocks and Critical Specifications
  - Industrial Robot Characteristics and Classifications
  - Robot Work-Cell Sensors
  - End-of-Arm Tooling with Industrial Robots
  - Programming Techniques
- 4% Automated Systems**
- Motor Control and Punch Press Applications

### Written Exam Reference Materials (Reference Current Edition)

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- **Programmable Logic Controllers** by Frank Petruzella (McGraw-Hill)
- **Introduction to Robotics, Module Robotics 701** (Schoolcraft Publishing) (<http://www.schoolcraftpublishing.com/Introduction-to-Robotics.html>)
- **Electronic Devices – Conventional** by Thomas Floyd (Prentice Hall)
- **Digital Fundamentals** by Thomas Floyd (Pearson/Prentice Hall)
- **Robotics Demystified: A Self-Teaching Guide** by Edwin Wise (McGraw-Hill)
- **Introduction to Engineering Design and Problem Solving** by Arvid Eide, Roland Jenison, Larry Northup, and Lane Mashaw (McGraw-Hill)
- **Design Concepts for Engineers** by Mark Horenstein (Prentice Hall)
- **Industrial Robotics and Automation** by A.K. Gupta (Mercury Learning & Information)

- **Internet Resources**

- **Robot Sensors:** [www.robotplatform.com](http://www.robotplatform.com)
- **Robotic Arms:** [http://en.wikipedia.org/wiki/Robotic\\_arm](http://en.wikipedia.org/wiki/Robotic_arm)
- **Industrial Robot Info:** [http://en.wikipedia.org/wiki/Industrial\\_robot](http://en.wikipedia.org/wiki/Industrial_robot)
- **Basic Logic Gates:** [http://en.wikipedia.org/wiki/Logic\\_gate](http://en.wikipedia.org/wiki/Logic_gate)
- **Ohm's Law:** [http://www.allaboutcircuits.com/vol\\_1/chpt\\_5/6.html](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>

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### 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.

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### 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 (\*).

Which of the following can be used to simulate the movement or track the flow of parts and information?

- a. Sequencer
- \*b. Shift register
- c. Math instruction
- d. Both A and B

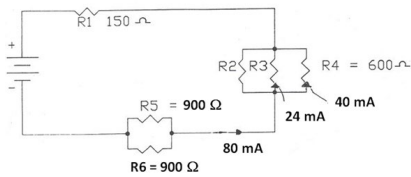
The primary difference between closed-loop and open-loop control in robots is the addition of the:

- a. control path.
- \*b. feedback path.
- c. point-to-point path.
- d. continuous path.

Which is a method of proportioning a sketch?

- a. Cut out a cardboard template.
- \*b. Use graph paper.
- c. Project the image on a wall.
- d. Use a compass.

In the circuit shown below, compute the value of R2:



- a. 150 ohms
- b. 300 ohms
- \*c. 1.5K ohms
- d. 3K ohms

## Performance Exam

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

### Performance Exam Content Coverage

#### **32% Speed and Direction Control of a Permanent Magnet DC Motor**

- Wire LM555 circuit to produce a PWM signal from given schematic
- Test LM555 circuit for duty cycle using an oscilloscope
- Wire L293 H-bridge circuit from given schematic
- Test and demonstrate working speed and direction motor control circuit

#### **38% PLC Application**

- Develop Boolean Expressions
- Simplify Boolean Expressions
- Develop PLC Input / Output list and Wire Inputs and Outputs
- Establish communication and programming software and write PLC program

#### **25% Robotic Work Cell**

- Identify and Diagram Given Work Envelope
- Identify, Describe and Diagram Given Power Sources
- Identify Degrees of Freedom and End-of-Arm Tooling
- Identify, Describe and Diagram Hard Wire Sensors

#### **5% Safety**

- Knowledge and Demonstration of Safety Practices

## Materials Required for the Performance Exam (Candidate Must Supply)

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- Face mask (cotton face covering or respirator which fully cover the nose and mouth)
- Personal Protective Safety Glasses
- Calculator
- Pens/Pencils

The following list of lab equipment/systems will be provided at the exam site:

- All electronic components and testing instrumentation, including a Dual Oscilloscope by Tektronix, Model: TBS 1072B-EDU.
- PLC: Allen-Bradley, MicroLogic 1100, Model 1763-L16BBB, Input Power 24V dc, Digital Inputs: (6) 24V dc and (4) High Speed, Analog Inputs: (2) Voltage Input, Digital Outputs: (2) relay, (2) 24V dc FET, (2) High Speed
- PLC programming software: RSLogic Micro Starter Lite.
- RSLinx Classic communication software Allen Bradley MicroLogic 1100 PLC.
- Fanuc LRMate 200iD/4s Robot with R-30iB Mate Controller.

Candidates have the option of bringing their own PLC system and appropriate hardware/software to be able to run the system and perform the required tasks. However, prior to bringing personal equipment, candidates are required to:

- a) Refer to the specs of the systems and equipment supplied by the performance exam test site and verify that the system performs similarly.
- b) Notify NOCTI at [nocti@nocti.org](mailto:nocti@nocti.org) no later than two weeks prior to the exam date to indicate what system/equipment, if any, you wish to bring to the exam.

**Notes:** If a component is blown (destroyed) due to faulty set up/wiring, the candidate will be given a second chance to correct the problem and continue the task with a grade point reduction. If the problem occurs again, the task will be terminated. Additional lab equipment/supplies will be provided. No books or notes will be allowed. Cell phones are prohibited during the exam administration.

## Onsite Performance Exam Requirements

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- 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)

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- **Programmable Logic Controllers** by Frank Petruzella (McGraw-Hill)
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(<http://www.schoolcraftpublishing.com/Introduction-to-Robotics.html>)
- **Electronic Devices – Conventional** by Thomas Floyd (Prentice Hall)
- **Digital Fundamentals** by Thomas Floyd (Pearson/Prentice Hall)
- **Robotics Demystified: A Self-Teaching Guide** by Edwin Wise (McGraw-Hill)
- **Robot Sensors:** [www.robotplatform.com](http://www.robotplatform.com)
- **OSHA Regulations** [www.osha.gov](http://www.osha.gov)
  - [1910.1200 - Hazard Communication](#)
  - [1910 Subpart I - Personal Protective Equipment](#)