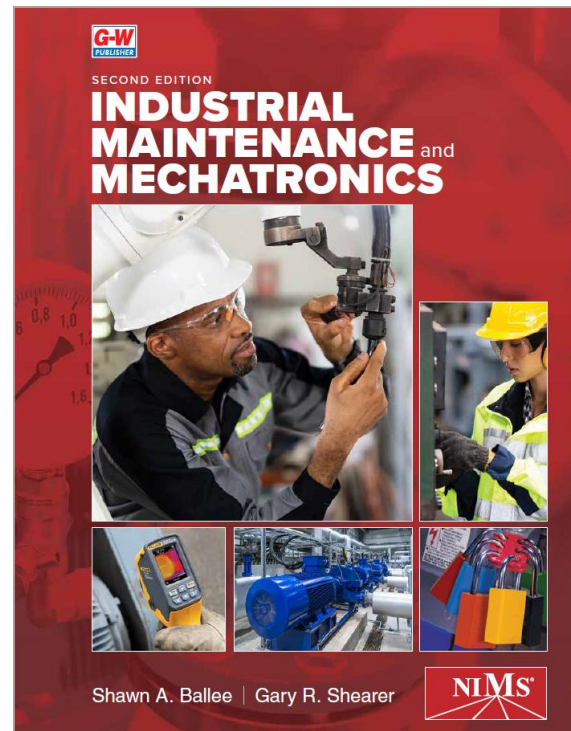## Correlation of
Industrial Maintenance and Mechatronics,
Shawn A. Ballee and Gary R. Shearer
Goodheart-Willcox Publisher ©2024
to
NIMS (National Institute for Metalworking Skills)
Classic Credential:
Electronic Control Systems

Industrial Maintenance and Mechatronics carries NIMS' exclusive endorsement and supports attainment of NIMS credentialing in Industrial Technology Maintenance (ITM).

The textbook is designed to work hand-in-glove with the NIMS Standards for Industrial Technology Maintenance. The standards-based learning package will help students pass the testing and performance requirements for NIMS credentialing.

The correlation below lists the standards for a specific NIMS Classic ITM Credential. The Classic ITM areas covered in *Industrial Maintenance and Mechatronics* include Maintenance Operations, Basic Mechanical Systems, Basic Hydraulic Systems, Basic Pneumatic Systems, Electrical Systems, Electronic Control Systems, Process Control Systems, and Maintenance Piping.

Standards	G-W Content
Duty Title: 6.01. Adhere to electronic power and control systems safety rules.	
Identify roles and responsibilities for safety, health, and environment.	Textbook: pg. 13, 24-28, 36-44, 70
Adhere to OSHA, NIOSH, EPA, and other federal and state safety requirements for the workplace.	Textbook: pg. 18, 24-25, 43-44
Identify and recognize common industrial hazards, per OSHA standards (including, ergonomics, laser safety, NFPA arc flash, confined space, gases and combustibles, steam, and compressed air).	Textbook: pg. 24-26
Define elements of a lockout/tagout (LOTO) program, describe the LOTO process and test to ensure a zero energy state.	Textbook: pg. 28-32 Lab Workbook: Activity 2-1, Lockout/Tagout Procedure

Standards	G-W Content
Identify and explain how to select the appropriate personal protective equipment (eyes, head, breathing air apparatus, body, feet, hands, ears) for a job.	Textbook: pg. 13, 32-35 Lab Workbook: Activity 2-2, Personal Protective Equipment
Explain how to locate a material Safety Data Sheet (SDS) and describe how you interpret the information.	Textbook: pg. 24-27
List and select proper fall protection for working at heights and using ladders, scaffolding, and lifts.	Textbook: pg. 37
Identify and recognize hazardous situations and apply proper procedures (includes following guidelines to prevent spread of bloodborne pathogens, spill control, proper storage, handling, protection of equipment, first aid).	Textbook: pg. 28-32, 36-43
Describe the process used to perform a job safety analysis.	Textbook: pg. 43 Lab Workbook: Activity 2-3, Job Safety Analysis
Explain the principles of 6S program (Sort, Sweep, Sanitize, Set-to-order, Sustain, Safety).	Textbook: pg. 43
Identify fuel source and selection of correct extinguisher class.	Textbook: pg. 43
ECS Specific:	
Describe safety procedures for disconnecting or connecting electronic components.	Textbook: pg. 428-429, 438-440 Lab Workbook: Activity 33-3, Wiring and Programming a VFD
Describe the hazards and precautionary safety procedures for working with electronic systems.	Textbook: pg. 28, 32-33, 35, 36, 39-42, 438-442 Lab Workbook: Activity 33-3, Wiring and Programming a VFD
Define the standards to adhere to grounding safety procedures.	Textbook: pg. 41 Lab Workbook: Activity 33-3, Wiring and Programming a VFD
Define the NFPA 70E arc flash guidelines and their importance.	Textbook: pg. 32, 35, 40
Duty Title: 6.02. Connect and test a DC power supply.	
Measure output from a DC power supply (to determine noise or quality of filtering).	Textbook: pg. 688, 690-691, 696-697 Lab Workbook: Activity 31-1, DC Power Supplies
Describe the operation of PN junction diodes, LEDs, Zener diodes, and voltage regulators.	Textbook: pg. 694-696
Describe the operation half wave and full wave rectifiers.	Textbook: pg. 691-693
Describe the operation of capacitive, inductive, and resistive power filters.	Textbook: pg. 690-691, 695–696
Describe the operation of bipolar and FET transistors (used in power supplies) and SCRS.	Textbook: pg. 704–710 Lab Workbook: Activity 32-1, Diode and Transistor Testing Lab Workbook: Activity 33-5, SCR Testing

Standards	G-W Content
Describe the operation of linear and switching power supplies.	Textbook: pg. 695–697
Connect and test linear and switching DC power supplies.	Textbook: pg. 696–698 Lab Workbook: Activity 31-1, DC Power Supplies
Duty Title: 6.03. Install and test a solid-state relay.	
Describe the operation of discrete and analog solid-state relays.	Textbook: pg. 748–749, 757–759 Lab Workbook: Activity 31-2, Solid-State Relay
Describe the operation of sourcing and sinking circuits.	Textbook: pg. 752–754, 755
Describe styles of solid-state relays and mountings.	Textbook: pg. 748–749, 755,
Interpret solid-state relay schematic symbols.	Textbook: pg. 757–758, 767 Lab Workbook: Activity 31-2, Solid-State Relay
Interpret solid-state relay specifications.	Lab Workbook: Activity 31-2, Solid-State Relay
Install solid-state relays in an electrical circuit given a schematic.	Textbook: pg. 755, 756 Lab Workbook: Activity 31-2, Solid-State Relay
Describe types of failures of solid-state relays.	Textbook: pg. 768
Use a multimeter to test a solid-state relay.	Textbook: pg. 755–756 Lab Workbook: Activity 31-2, Solid-State Relay
Duty Title: 6.04. Install and test analog electronic sensors.	
Describe the operation of 4-20 mA current output and voltage output signals.	Textbook: pg. 754–756
Describe the operation of signal conditioners for analog sensors.	Textbook: pg. 720
Describe the operation of thermistors, RTD temperature sensors, and thermocouples.	Textbook: pg. 727
Describe the operation of resistive, capacitive, and piezoelectric pressure sensors.	Textbook: pg. 727
Interpret specifications for analog sensors.	Textbook: pg. 594–601
Connect and test sensors and associated signal conditioner.	Textbook: pg. 720-727 Lab Workbook: Activity 33-1, Capacitive, Inductive, Hall Effect, and Magnetic Reed Sensors Lab Workbook: Activity 33-2, Photoelectric Sensors
Describe types of failures of analog sensors.	Textbook: pg. 727, 740–741, 765–768
Adjust the range and zero point of an analog signal conditioner.	Textbook: pg. 720–722 Lab Workbook: Activity 33-1, Capacitive, Inductive, Hall Effect, and Magnetic Reed Sensors Lab Workbook: Activity 33-2, Photoelectric Sensors

Standards	G-W Content
Duty Title: 6.05. AC variable frequency drive.	
Describe the operation of an AC VFD motor control system.	Textbook: pg. 728–729, 730–733 Lab Workbook: Activity 33-3, Wiring and Programming a VFD Lab Workbook: Activity 33-4, Adjusting VFD Parameters
Describe the function and use of common AC drive parameters.	Textbook: pg. 730, 736–737 Lab Workbook: Activity 33-3, Wiring and Programming a VFD Lab Workbook: Activity 33-4, Adjusting VFD Parameters
Describe the operation of IGBT and FET transistors as used in VFDs.	Textbook: pg. 728–733
Describe VFD alarms/diagnostics and their importance.	Textbook: pg. 734–737
Explain purpose of a grounding ring and its use with a VFD.	Textbook: pg. 733
Connect and operate an AC variable frequency drive (VFD) with an AC motor and relay control circuit.	Textbook: pg. 731–733 Lab Workbook: Activity 33-3, Wiring and Programming a VFD Lab Workbook: Activity 33-4, Adjusting VFD Parameters
Explain and manually operate an AC VFD using an onboard HMI.	Textbook: pg. 736–737 Lab Workbook: Activity 33-3, Wiring and Programming a VFD Lab Workbook: Activity 33-4, Adjusting VFD Parameters
View and edit parameters in an AC VFD using an onboard HMI.	Textbook: pg. 736–737 Lab Workbook: Activity 33-3, Wiring and Programming a VFD Lab Workbook: Activity 33-4, Adjusting VFD Parameters
Duty Title: 6.06. Transfer programs to a programmable controller using a PC.	
Describe the basic operation of a PLC.	Textbook: pg. 748–749
Describe the basic operation and navigation of PC software for PLCs.	Textbook: pg. 749–751 Lab Workbook: Activity 34-1, Basic PLC Setup and Programming
Describe the nomenclature used for PLC program file elements.	Textbook: pg. 759–760
Describe how PLCs are wired to power, I/O, and network devices.	Textbook: pg. 751–756, 757–759 Lab Workbook: Activity 34-1, Basic PLC Setup and Programming
Describe the operation of a PLC network.	Textbook: pg. 749–751

Standards	G-W Content
Describe how devices are identified on a PLC network.	Textbook: pg. 751
Describe the use and importance of comments in ladder logic.	Textbook: pg. 757–758
Change PLC modes.	Textbook: pg. 749–750 Lab Workbook: Activity 34-1, Basic PLC Setup and Programming Lab Workbook: Activity 34-2, Basic PLC Troubleshooting
Connect and transfer programs between a PC and a programmable controller via a serial, USB, or Ethernet connection.	Textbook: pg. 748, 776–778, 781 Lab Workbook: Activity 34-1, Basic PLC Setup and Programming Lab Workbook: Activity 34-2, Basic PLC Troubleshooting Lab Workbook: Activity 34-3, PLC Timer Programming Lab Workbook: Activity 34-4, PLC Counter Instructions Lab Workbook: Activity 34-5, PLC System Control
Duty Title: 6.07. Create a basic PLC ladder-style program.	
Use PC software to open a PLC program and review the files.	Textbook: pg. 757, 758, 759–764 Lab Workbook: Activity 34-1, Basic PLC Setup and Programming Lab Workbook: Activity 34-2, Basic PLC Troubleshooting Lab Workbook: Activity 34-3, PLC Timer Programming Lab Workbook: Activity 34-4, PLC Counter Instructions Lab Workbook: Activity 34-5, PLC System Control
Interpret PLC programs with internal and external contacts, timers, counters, non-retentive output coils, internal coils, subroutines, conditional commands, and math commands.	Textbook: pg. 751, 757,758, 762–764, Lab Workbook: Activity 34-3, PLC Timer Programming Lab Workbook: Activity 34-4, PLC Counter Instructions Lab Workbook: Activity 34-5, PLC System Control

Standards	G-W Content
Interpret PLC programs that control and sequence electric motors and fluid power systems.	Textbook: pg. 760–761, 764 Lab Workbook: Activity 34-1, Basic PLC Setup and Programming Lab Workbook: Activity 34-2, Basic PLC Troubleshooting Lab Workbook: Activity 34-3, PLC Timer Programming Lab Workbook: Activity 34-4, PLC Counter Instructions Lab Workbook: Activity 34-5, PLC System Control
Interpret a PLC I/O diagram.	Textbook: pg. 753–756 Lab Workbook: Activity 34-1, Basic PLC Setup and Programming
Identify an I/O device given a memory address.	Textbook: pg. 758–759, 783 Lab Workbook: Activity 34-1, Basic PLC Setup and Programming
Describe the function of an analog I/O card.	Textbook: pg. 751–756
Describe the address scheme of a PLC.	Textbook: pg. 759–760
Describe the operation of basic PLC commands including: internal and external contacts, timers, counters, non-retentive output coils, internal coils.	Textbook: pg. 759–762 Lab Workbook: Activity 34-1, Basic PLC Setup and Programming Lab Workbook: Activity 34-2, Basic PLC Troubleshooting Lab Workbook: Activity 34-3, PLC Timer Programming Lab Workbook: Activity 34-4, PLC Counter Instructions Lab Workbook: Activity 34-5, PLC System Control
Duty Title: 6.08. Install and test a HMI and PLC System.	
Connect and configure a HMI to a PLC via a network or direct connection.	Textbook: pg. 781 Lab Workbook: Activity 35-1, Connecting HMI to PLC
Install and configure a PLC and its components.	Textbook: pg. 781–782 Lab Workbook: Activity 34-1, Basic PLC Setup and Programming
Power up a HMI.	Textbook: pg. 783–784
View data from a HMI panel.	Textbook: pg. 784–785
Navigate HMI screens using touchscreen and function keys.	Textbook: pg. 785–787 Lab Workbook: Activity 35-2, Programming Multiple Screens on HMI

Standards	G-W Content
Interpret the operation of a PLC program that uses a ladder logic program to interface to a hardware component.	Textbook: pg. 757–764 Lab Workbook: Activity 34-1, Basic PLC Setup and Programming
Duty Title: 6.09. Basic mechatronic troubleshooting.	
Use a PLC troubleshooting flowchart to troubleshoot a PLC system.	Textbook: pg. 765–768 Lab Workbook: Activity 34-2, Basic PLC Troubleshooting
Use PLC program history to troubleshoot a PLC system.	Textbook: pg. 765–768 Lab Workbook: Activity 34-2, Basic PLC Troubleshooting
Use systematic methodologies to troubleshoot a basic PLC-controlled machine or system and its components.	Textbook: pg. 765–767 Lab Workbook: Activity 34-2, Basic PLC Troubleshooting
Use a HMI to troubleshoot a PLC-controlled machine.	Textbook: pg. 786–789
Troubleshoot a HMI on a PLC-controlled machine.	Textbook: pg. 786–789 Lab Workbook: Activity 35-3, PLC Set Points and HMI Troubleshooting
Make mechanical, electrical and software adjustments to tune the performance of a PLC-controlled machine.	Textbook: pgs. 757–764, 786–788 Lab Workbook: Activity 34-3, PLC Timer Programming Lab Workbook: Activity 34-4, PLC Counter Instructions Lab Workbook: Activity 34-5, PLC System Control
Use team skills to install, troubleshoot, and optimize systems.	Textbook: pg. 748–759, 765–765 Lab Workbook: Activity 34-1, Basic PLC Setup and Programming Lab Workbook: Activity 34-2, Basic PLC Troubleshooting Lab Workbook: Activity 34-5, PLC System Control