

A Correlation of
Mechatronics Volumes 1 and 2
Core Curriculum
Electrical Level 1
Electrical Level 2
Millwright Level 4
Electronic Systems Technician Level 2
Instrumentation Level 4



To the
South Carolina Standards for
Mechatronics 1, 2, 3, & 4

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Required Competencies	
South Carolina Mechatronics	Core Curriculum Electrical Level 1 Electrical Level 2 Millwright Level 4 Electronic Systems Technician [EST] Level 2 Instrumentation Level 4
INDUSTRIAL SAFETY (SECTION 1) 1-4	
1. Explain the idea of a safety culture and its importance to mechatronics.	Core Curriculum (Module 00101-15): pgs. 1-10
2. Identify causes of accidents and the impact of accident costs.	Core Curriculum (Module 00101-15): pgs. 1-9
3. Explain the role of OSHA in job-site safety.*	Core Curriculum (Module 00101-15): pgs. 94-96 Electrical Level 1 (Module 26102-14): pgs. 10-17
4. Explain OSHA's General Duty Clause and 1926 CFR Subpart C.	Core Curriculum (Module 00101-15): pg. 94 Electrical Level 1 (Module 26102-14): pgs. 10-17
5. Recognize hazard recognition and risk assessment techniques.	Core Curriculum (Module 00101-15): pgs. 9-12
6. Explain fall protection and ladder, stair, and scaffold procedures and requirements.	Core Curriculum (Module 00101-15): pgs. 16-38 Electrical Level 1 (Module 26102-14): pgs. 18-20, 31-36
7. Identify struck-by hazards.	Core Curriculum (Module 00101-15): pgs. 40-48
8. Demonstrate safe working procedures and requirements related to lock out-tag out procedures.	Core Curriculum (Module 00101-15): pgs. 50-57 Electrical Level 1 (Module 26102-14): pgs. 1-4
9. Identify caught-in-between hazards.	Core Curriculum (Module 00101-15): pgs. 43-48
10. Demonstrate safe working procedures and requirements related to caught-in-between hazards.	Core Curriculum (Module 00101-15): pgs. 43-48
11. Demonstrate safe work procedures to use around electrical hazards.	Core Curriculum (Module 00101-15): pgs. 50-57 Electrical Level 1 (Module 26102-14): pgs. 1-4
12. Demonstrate the use and care of appropriate personal protective equipment (PPE).	Core Curriculum (Module 00101-15): pgs. 58-65 Electrical Level 1 (Module 26102-14): pgs. 4-10
13. Explain the importance of hazard communications (HazCom) and Material Safety Data Sheets (MSDSs).	Core Curriculum (Module 00101-15): pgs. 9-15
14. Identify other construction hazards on your job site, including hazardous material exposures, environmental elements, welding and cutting hazards, confined spaces, and fires.	Core Curriculum (Module 00101-15): pgs. 67-86
HAND AND POWER TOOL OPERATIONS (SECTION 2)	
1. Illustrate use of basic hand and power tools (see tools and equipment list).	Core Curriculum (Module 00103-15) Core Curriculum (Module 00104-15)
2. Use torque wrenches.	Core Curriculum (Module 00103-15): pgs. 13-15 Core Curriculum (Module 00104-15): pgs. 11-13
3. Describe the basic procedures for taking care of hand and power tools.	Core Curriculum (Module 00103-15): pgs. 5-6, 8, 9, 12-13, 15, 17, 21, 22, 31, 35, 37, 38, 40 Core Curriculum (Module 00104-15): pgs. 7-10, 13, 17-18, 19-20, 21, 22, 26-28, 33-34, 36
4. Use hand and power tools safely.	Core Curriculum (Module 00103-15): pgs. 5-6, 8, 9, 12-13, 15, 17, 21, 22, 31, 35, 37, 38, 40 Core Curriculum (Module 00104-15): pgs. 7-10, 13, 17-18, 19-20, 21, 22, 26-28, 33-34, 36
5. Demonstrate how to maintain hand and power tools properly.	Core Curriculum (Module 00103-15): pgs. 5-6, 8, 9, 12-13, 15, 17, 21, 22, 31, 35, 37, 38, 40 Core Curriculum (Module 00104-15): pgs. 7-10, 13, 17-18, 19-20, 21, 22, 26-28, 33-34, 36
6. Compare the use of threaded fasteners and non-threaded fasteners.	NA
7. Demonstrate applications for fasteners and anchors.	NA
8. Demonstrate use of precision measurement tools (English/standard and metric).	
a. Use levels.	Core Curriculum (Module 00103-15): pgs. 22

b. Use feeler gauges.	Core Curriculum (Module 00102-15): pg. 68
c. Use calipers.	Core Curriculum (Module 00103-15): pg. 21
d. Use micrometers.	Core Curriculum (Module 00103-15): pg. 21
e. Use dial indicators.	Core Curriculum (Module 00103-15): pg. 21
f. Use protractors.	Core Curriculum (Module 00103-15): pgs. 24, 26
g. Use parallels and gauge blocks.	NA
h. Use precision straightedges.	Core Curriculum (Module 00103-15): pgs. 19, 24
i. Use a standard ruler and a metric ruler to measure.	Core Curriculum (Module 00103-15): pgs. 19-21
9. Evaluate the metric system and how it is important in mechatronics.	Core Curriculum (Module 00102-15): pgs. 30-31, 33, 38-39, 43, 65
10. Use metric units of length, weight, volume, and temperature.	Core Curriculum (Module 00102-15): pgs. 30-31, 33, 38-39, 43, 65
11. Convert English/standard to metric.	Core Curriculum (Module 00102-15): pgs. 30-31, 33, 38-39, 43, 65
12. Demonstrate the ability to perform layout work to include the use of calipers, drills, height and depth gauges, and other measurement tools.	NA
HYDRAULICS AND PNEUMATICS (SECTION 3)	
1. Demonstrate hydraulic system safety.	Millwright Level 4 (Module 15409-08): pgs. 9.2
2. Explain the principles of hydraulics and hydraulic fluids.	Millwright Level 4 (Module 15409-08): pgs. 9.2-9.10
3. Identify hydraulic components (supply elements, control valves, and actuators).	Millwright Level 4 (Module 15409-08): pgs. 9.10-9.28
4. Explain hydraulic systems (forces, speed, friction, flow, and pressure).	Millwright Level 4 (Module 15409-08): pgs. 9.2-9.8
5. Identify types of hydraulic pumps.	Millwright Level 4 (Module 15409-08): pgs. 9.28-9.34
6. Identify types of hydraulic motors.	Millwright Level 4 (Module 15409-08): pgs. 9.34-9.37
7. Demonstrate pneumatic safety.	Millwright Level 4 (Module 15407-08): pgs. 7.2
8. Calculate the physical characteristics and compressibility of gases (Pascal's law and Boyle's law).	Millwright Level 4 (Module 15407-08): pgs. 7.2-7.3
9. Describe the pneumatic transmission of energy.	Millwright Level 4 (Module 15407-08): pg. 7.4
10. Identify types of compressors.	Millwright Level 4 (Module 15407-08): pgs. 7.5-7.7, 7.13
11. Analyze the principles of compressor operation and compressed-air treatment.	Millwright Level 4 (Module 15407-08): pgs. 7.4-7.15
12. Construct pneumatic systems from components and symbols.	Millwright Level 4 (Module 15407-08): pgs. 7.15-7.22
13. Demonstrate the ability to read, construct, and interpret fluid power symbols as well as fluid power diagrams.	Millwright Level 4 (Module 15407-08): pgs. 7.20, 7.22 Millwright Level 4 (Module 15408-08): pgs. 8.11-8.13 Millwright Level 4 (Module 15410-08): pgs. 10.7-10.9
14. Demonstrate correct installation and maintenance as well as preventive maintenance techniques for fluid power systems using service manuals.	Millwright Level 4 (Module 15408-08): pgs. 8.2-8.5, 8.18, 8.20-8.21 Millwright Level 4 (Module 15410-08): pgs. 10.10, 10.13-10.21
15. Troubleshoot and repair fluid power systems using service manuals and gauges.	Millwright Level 4 (Module 15408-08): pgs. 8.11, 8.13-8.19 Millwright Level 4 (Module 15410-08): pgs. 10.10-10.12
AC-DC CIRCUITS (SECTION 4)	
1. Recognize what atoms are and how they are constructed.	EST Level 2 (Module 33201-10): pgs. 1.1-1.2, 1.30
2. Identify ways in which voltage can be produced.	EST Level 2 (Module 33201-10): pgs. 1.4-1.6
3. Demonstrate the difference between conductors and insulators.	EST Level 2 (Module 33201-10): pgs. 1.1, 1.3, 1.7, 1.30
4. Define the units of measurement that are used to measure the properties of electricity.	EST Level 2 (Module 33201-10): pgs. 1.13-1.15
5. Explain how voltage, current, and resistance are related to each other.	EST Level 2 (Module 33201-10): pgs. 1.6-1.9 EST Level 2 (Module 33202-10): pg. 2.11
6. Calculate electrical quantities using Ohm's Law.	EST Level 2 (Module 33201-10): pgs. 1.8-1.9, 1.14-1.15, 1.22-1.24 EST Level 2 (Module 33202-10): pg. 2.11
7. Calculate the amount of power used by a circuit.	EST Level 2 (Module 33201-10): pgs. 1.13-1.27
8. Demonstrate understanding of capacitance and inductance in a DC circuit.	EST Level 2 (Module 33202-10): pgs. 2.12-2.20
9. Construct a basic series circuit.	EST Level 2 (Module 33201-10): pgs. 1.15-1.18 EST Level 2 (Module 33202-10): pgs. 2.24-2.32
10. Construct a basic parallel circuit.	EST Level 2 (Module 33201-10): pgs. 1.16-1.19 EST Level 2 (Module 33202-10): pgs. 2.24-2.34
11. Construct a series-parallel combination circuit.	EST Level 2 (Module 33201-10): pgs. 1.16-1.17, 1.20-1.22

12. Calculate, using Kirchoff's Voltage Law, the voltage drop and total current in series, parallel, and series-parallel circuits.	EST Level 2 (Module 33201-10): pgs. 1.25-1.27, 1.30
13. Measure the total amount of resistance in a series circuit.	EST Level 2 (Module 33201-10): pgs. 1.8, 1.17-1.18
14. Measure the total amount of resistance in a parallel circuit.	EST Level 2 (Module 33201-10): pgs. 1.8, 1.18-1.19
15. Measure the total amount of resistance in a series-parallel circuit.	EST Level 2 (Module 33201-10): pgs. 1.8, 1.17
16. Compare calculated and measured electrical properties.	EST Level 2 (Module 33201-10): pgs. 1.8-1.9, 1.14-1.15, 1.22-1.24
ELECTRICAL TEST EQUIPMENT	
1. Demonstrate the operation of the following pieces of test equipment: 1-4	
-Ammeter	Electrical Level 1 (Module 26112-14): pgs. 5-6
-Voltmeter	Electrical Level 1 (Module 26112-14): pgs. 5-6
-Ohmmeter	Electrical Level 1 (Module 26112-14): pgs. 3-7
-Multimeter*	Electrical Level 1 (Module 26112-14): pgs. 5-6
-Frequency meter 4	Electrical Level 1 (Module 26112-14): pg. 6
-Oscilloscope 4	EST Level 2 (Module 33205-10): pgs. 5.18-5.25
-Continuity tester	EST Level 2 (Module 33205-10): pg. 5.16
-Voltage tester	EST Level 2 (Module 33205-10): pgs. 5.16-5.18
2. Represent results using engineering notation.	NA
3. Understand the importance of proper meter polarity.	NA
4. Demonstrate frequency using a frequency meter.	Electrical Level 1 (Module 26112-14): pg. 6
5. Compare the difference between digital and analog meters.	Electrical Level 1 (Module 26112-14): pg. 6 EST Level 2 (Module 33205-10): pgs. 5.10-5.14, 5.18-5.19
OPTIONAL ADVANCED STANDARDS	
ADVANCED AC CIRCUITS	
1. Calculate the peak and effective voltage or current values for an AC waveform.	EST Level 2 (Module 33202-10): pgs. 2.9-2.12
2. Calculate the phase relationship between two AC waveforms.	EST Level 2 (Module 33202-10): pgs. 2.9-2.12
3. Measure the voltage and current phase relationship in a resistive AC circuit.	EST Level 2 (Module 33202-10): pgs. 2.18-2.19
4. Describe the voltage and current transients that occur in an inductive circuit.	EST Level 2 (Module 33202-10): pgs. 2.13-2.14
5. Define inductive reactance.	EST Level 2 (Module 33202-10): pgs. 2.14-2.15
6. Describe the voltage and current transients that occur in a capacitive circuit.	EST Level 2 (Module 33202-10): pgs. 2.15-2.19
7. Define capacitive reactance.	EST Level 2 (Module 33202-10): pgs. 2.19-2.20
8. Construct circuits showing the relationship between voltage and current in the following types of AC circuits:	EST Level 2 (Module 33202-10): pgs. 2.20-2.29
-RL circuit	EST Level 2 (Module 33202-10): pgs. 2.21-2.26
-LC circuit	EST Level 2 (Module 33202-10): pgs. 2.27-2.29
9. Describe the effect that resonant frequency has on impedance and current flow in a series or parallel resonant circuit.	EST Level 2 (Module 33202-10): pgs. 2.12, 2.20
10. Describe how bandwidth is affected by resistance in a series or parallel resonant circuit.	EST Level 2 (Module 33202-10): pgs. 2.32-2.34
11. Describe the following terms as they relate to AC circuits:	
-True power	EST Level 2 (Module 33202-10): pg. 2.35
-Reactive power	EST Level 2 (Module 33202-10): pgs. 2.35-2.36
-Apparent power	EST Level 2 (Module 33202-10): pg. 2.35
-Power factor	EST Level 2 (Module 33202-10): pgs. 2.36-2.37
12. Describe operation of a transformer.	EST Level 2 (Module 33202-10): pgs. 2.38-2.46
PROGRAMMABLE LOGIC CONTROLLERS	
1. Describe the function and purpose of a programmable logic controller (PLC).	Instrumentation Level 4 (Module 12406-03): pgs. 6.2-6.8
2. Compare hardwired and PLC systems.	Instrumentation Level 4 (Module 12406-03): pgs. 6.2-6.8
3. Convert between number systems.	Instrumentation Level 4 (Module 12406-03): pgs. 6.8-6.12
4. Analyze a binary logic network.	Instrumentation Level 4 (Module 12406-03): pgs. 6.11-6.12
5. Describe the purpose of the various power supplies used within a PLC.	Instrumentation Level 4 (Module 12406-03): pgs. 6.12-6.13
6. Construct input/output (I/O) circuits.	Instrumentation Level 4 (Module 12406-03): pgs. 6.13-6.15
7. Define the function of the PLC processor module.	Instrumentation Level 4 (Module 12406-03): pgs. 6.17-6.18

8. Describe the interrelations between microprocessor components.	Instrumentation Level 4 (Module 12406-03): pgs. 6.12-6.17
9. State the characteristics of the different types of memory.	Instrumentation Level 4 (Module 12406-03): pgs. 6.18-6.19
10. Demonstrate the features of relay ladder logic instruction categories.	Instrumentation Level 4 (Module 12406-03): pgs. 6.19-6.20
11. Demonstrate the principles used to correlate PLC hardware components to software instructions.	Instrumentation Level 4 (Module 12406-03): pg. 6.27
12. Convert a hardware ladder diagram to a PLC ladder diagram.	Instrumentation Level 4 (Module 12406-03): pg. 6.21
13. Program PLC using the converted PLC ladder diagram.	Instrumentation Level 4 (Module 12406-03): pg. 6.21
14. Troubleshoot problems in PLC circuit using a given diagram.	Instrumentation Level 4 (Module 12406-03): pg. 6.29
INTRODUCTION TO ROBOTICS SYSTEMS	This topic falls outside of the curriculum.
1. Explain basic safety of robotics systems.	
2. Explain OSHA requirements for robotics systems.	
3. Construct a process application for robotics systems.	
4. Describe the different types of robots.	
5. Identify the different parts of a robot and their functions.	
6. Demonstrate the ability to service, maintain, and troubleshoot a simple robot.	
7. Demonstrate robotic coordinate systems.	
MOTORS: THEORY AND APPLICATION	
1. Define the following terms:	
-Ampacity	Electrical Level 2 (Module 26202-14): pg. 52
-Branch circuit	Electrical Level 2 (Module 26202-14): pgs. 52-53, 65
-Circuit breaker	Electrical Level 2 (Module 26202-14): pg. 65
-Controller	Electrical Level 2 (Module 26202-14): pg. 65
-Duty	Electrical Level 2 (Module 26202-14): pg. 65
-Equipment	Electrical Level 2 (Module 26202-14): pg. 65
-Full-load amps	Electrical Level 2 (Module 26202-14): pg. 47
-Ground fault circuit interrupter	NA
-Interrupting rating	NA
-Motor circuit switch	NA
-Thermal protector	Electrical Level 2 (Module 26202-14): pgs. 51-52
-NEMA design letter	Electrical Level 2 (Module 26202-14): pg. 48
-Nonautomatic	Electrical Level 2 (Module 26202-14): pg. 65
-Overcurrent	Electrical Level 2 (Module 26202-14): pgs. 47 65
-Overload	Electrical Level 2 (Module 26202-14): pg. 21
-Power factor	Electrical Level 2 (Module 26202-14): pgs. 21-22
-Rated full-load speed	Electrical Level 2 (Module 26202-14): pg. 47
-Rated horsepower	Electrical Level 2 (Module 26202-14): pg. 47
-Service factor	Electrical Level 2 (Module 26202-14): pg. 49
-Thermal cutout	NA
-Remote control circuit	NA
2. Describe the various types of motor enclosures.	Electrical Level 2 (Module 26202-14): pgs. 41-43
3. Describe how the rated voltage of a motor differs from the system voltage.	Electrical Level 2 (Module 26202-14): pg. 46
4. Describe the basic construction and components of a three-phase squirrel cage induction motor.	Electrical Level 2 (Module 26202-14): pg. 16
5. Explain the relationships among speed, frequency, and the number of poles in a three-phase induction motor.	Electrical Level 2 (Module 26202-14): pgs. 16-18
6. Describe how torque is developed in an induction motor.	Electrical Level 2 (Module 26202-14): pgs. 18-19
7. Explain how and why torque varies with rotor reactance and slip.	Electrical Level 2 (Module 26202-14): pgs. 18-19
8. Define percent slip and speed regulation.	Electrical Level 2 (Module 26202-14): pgs. 18-21
9. Explain how the direction of a three-phase motor is reversed.	Electrical Level 2 (Module 26202-14): pgs. 22-23
10. Describe the component parts and operating characteristics of a three-phase wound rotor induction motor.	Electrical Level 2 (Module 26202-14): pgs. 16-23
11. Describe the component parts and operating characteristics of a three-phase synchronous motor.	Electrical Level 2 (Module 26202-14): pg. 26

12. Define torque, starting current, and armature reaction as they apply to DC motors.	Electrical Level 2 (Module 26202-14): pgs. 6-7
13. Explain how the direction of rotation of a DC motor is changed.	Electrical Level 2 (Module 26202-14): pgs. 2-3
14. Describe the design and characteristics of a DC shunt, series, and compound motor.	Electrical Level 2 (Module 26202-14): pgs. 9-11, 39
15. Describe dual-voltage motors and their applications.	Electrical Level 2 (Module 26202-14): pgs. 53, 57
16. Describe the methods for determining various motor connections.	Electrical Level 2 (Module 26202-14): pgs. 53-56
17. Describe general motor protection requirements as delineated in the National Electrical Code (NEC).	Electrical Level 2 (Module 26202-14): pgs. 50-53

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