MECHATRONICS INTEGRATED TECHNOLOGIES 1- 4
CODE: 6210, 6211, 6212, and 6213

PROGRAM DESCRIPTION: Mechatronics is a new interdisciplinary field involving electrical, mechanical, instrumentation, electronics, robotics/automation, computer components, and control systems. The program prepares students who enjoy working with their hands as well as understanding simple to complex systems. Mechatronics is a dynamic field that changes daily with the rapid improvements in technology and computer systems. Systems are networked to meet the demands of automated manufacturing processes, and technicians are trained to meet necessary entry-level industrial skills and entry into a postsecondary program at a technical college. Dual credit may be available through some SC technical colleges.

Provided a student takes Introduction to Construction and scores 70% on all assessments (00101-8-15), he or she does not have to repeat these modules in HVAC, Building Construction, Cabinetmaking, Carpentry, Electricity, Masonry, Mechatronics, Plumbing, and Welding.

OBJECTIVE: Given the necessary equipment, materials, and instruction, the student, on completion of the prescribed course of study, will be able to successfully accomplish the following standards.

RECOMMENDED GRADE LEVELS:	9 - 12
CREDIT:	1 unit (120 hours), 2 units (240 hours) per activity code
PREREQUISITE:	None
RESOURCES:	Textbooks SC Mechatronics Weebly must contact Steven Watterson for password. Carolina Training Associates Learning Labs Southern Educational Systems NCCER

A. SAFETY

Effective professionals know the academic subject matter, including safety as required for proficiency within their area. They will use this knowledge as needed in their role. The following accountability criteria are considered essential for students in any program of study.

1. Review school safety policies and procedures.
2. Review classroom safety rules and procedures.
3. Review safety procedures for using equipment in the classroom.
4. Identify major causes of work-related accidents in office environments.
5. Demonstrate safety skills in an office/work environment.

B. STUDENT ORGANIZATIONS

Effective professionals know the academic subject matter, including professional development, required for proficiency within their area. They will use this knowledge as needed in their role. The following accountability criteria are considered essential for students in any program of study.

1. Identify the purpose and goals of a Career and Technology Student Organization (CTSO).
2. Explain how CTSOs are integral parts of specific clusters, majors, and/or courses.
3. Explain the benefits and responsibilities of being a member of a CTSO.
4. List leadership opportunities that are available to students through participation in CTSO conferences, competitions, community service, philanthropy, and other activities.
5. Explain how participation in CTSOs can promote lifelong benefits in other professional and civic organizations.

C. TECHNOLOGY KNOWLEDGE

Effective professionals know the academic subject matter, including the ethical use of technology as needed in their role. The following accountability criteria are considered essential for students in any program of study.

1. Demonstrate proficiency and skills associated with the use of technologies that are common to a specific occupation.
2. Identify proper netiquette when using e-mail, social media, and other technologies for communication purposes.
3. Identify potential abuse and unethical uses of laptops, tablets, computers, and/or networks.
4. Explain the consequences of social, illegal, and unethical uses of technology (e.g., piracy; illegal downloading; licensing infringement; inappropriate uses of software, hardware, and mobile devices in the work environment).
5. Discuss legal issues and the terms of use related to copyright laws, fair use laws, and ethics pertaining to downloading of images, photographs, documents, video, sounds, music, trademarks, and other elements for personal use.
6. Describe ethical and legal practices of safeguarding the confidentiality of business-related information.
7. Describe possible threats to a laptop, tablet, computer, and/or network and methods of avoiding attacks.

D. PERSONAL QUALITIES AND EMPLOYABILITY SKILLS

Effective professionals know the academic subject matter, including positive work practices and interpersonal skills, as needed in their role. The following accountability criteria are considered essential for students in any program of study.

1. Demonstrate punctuality.
2. Demonstrate self-representation.
3. Demonstrate work ethic.
4. Demonstrate respect.
5. Demonstrate time management.
6. Demonstrate integrity.
7. Demonstrate leadership.
8. Demonstrate teamwork and collaboration.
9. Demonstrate conflict resolution.
10. Demonstrate perseverance.
11. Demonstrate commitment.
12. Demonstrate a healthy view of competition.
13. Demonstrate a global perspective.
14. Demonstrate health and fitness.
15. Demonstrate self-direction.
16. Demonstrate lifelong learning.

E. PROFESSIONAL KNOWLEDGE

Effective professionals know the academic subject matter, including positive work practices and interpersonal skills, as needed in their role. The following accountability criteria are considered essential for students in any program of study.

1. Demonstrate effective speaking and listening skills.
2. Demonstrate effective reading and writing skills.
3. Demonstrate mathematical reasoning.
4. Demonstrate job-specific mathematics skills.
5. Demonstrate critical-thinking and problem-solving skills.
6. Demonstrate creativity and resourcefulness.
7. Demonstrate an understanding of business ethics.
8. Demonstrate confidentiality.
9. Demonstrate an understanding of workplace structures, organizations, systems, and climates.
10. Demonstrate diversity awareness.
11. Demonstrate job acquisition and advancement skills.
12. Demonstrate task management skills.
13. Demonstrate customer-service skills.

NCCER CONTREN® CORE MODULES

MODULE A: BASIC SAFETY

Effective manufacturing professionals demonstrate basic safety knowledge as needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Identify the responsibilities and personal characteristics of a professional craftsperson.
2. Describe the safe work requirements for elevated work.
3. Identify and explain how to avoid struck-by and caught-in-between hazards.
4. Explain the appropriate safety precautions around common job-site hazards.
5. Demonstrate the use and care of appropriate personal protective equipment (PPE).
6. Identify and describe other specific job-site safety hazards.
7. Follow safe procedures for lifting heavy objects.
8. Describe safe behavior on and around ladders and scaffolds.
9. Explain the importance of the Hazard Communication Standard (HazCom) requirement and Safety Data Sheets (SDS)
10. Describe fire prevention and firefighting techniques.
11. Define safe work procedures around electrical hazards.
12. Complete 10-hour OSHA course/assessment and receive card. (SDE Requirement)
13. Complete Performance Tasks

MODULE B: BASIC MATH

Effective manufacturing professionals demonstrate basic math skills as needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Add, subtract, multiply, and divide whole numbers, with and without a calculator.
2. Use a standard ruler and a metric ruler to measure.
3. Add, subtract, multiply, and divide fractions.
4. Add, subtract, multiply, and divide decimals, with and without a calculator.
5. Convert decimals to percent and percent to decimals.
6. Convert fractions to decimals and decimals to fractions.
7. Explain what the metric system is and how it is important in the construction trade.
8. Recognize and use metric units of length, weight, volume, and temperature.
9. Recognize some of the basic shapes used in the construction industry and apply basic geometry to measure them.

MODUCLE C: INTRODUCTION TO HAND TOOLS

Effective manufacturing professionals demonstrate how to safely use various hand tools as needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Recognize and identify various types of basic hand tools used in the construction trade.
2. Identify and describe how to use various types of measurement and layout tools.
3. Identify and explain how to use various types of cutting and shaping tools.
4. Use these tools safely.
5. Describe the basic procedures for taking care of these tools.
6. Complete Performance Tasks

MODULE D: INTRODUCTION TO POWER TOOLS

Effective manufacturing professionals demonstrate how to safely use power tools as needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Identify and explain how to use various types of power drills and impact wrenches used in the construction trade.
2. Identify and explain how to use various types of power saws.
3. Identify and explain how to use various grinders and grinder attachments.
4. Identify and explain how to use miscellaneous power tools.
5. Use power tools safely.
6. Explain how to maintain power tools properly.
7. Complete Performance Tasks

MODULE E: INTRODUCTION TO CONSTRUCTION DRAWINGS

Effective manufacturing professionals demonstrate knowledge and the use of blueprints/construction drawings as needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Identify and describe various types of construction drawings, including their fundamental components and features.
2. Recognize and identify basic blueprint terms, components, and symbols.
3. Relate information on blueprints to actual locations on the print.
4. Recognize different classifications of drawings.
5. Interpret and use drawing dimensions.
6. Complete Performance Tasks

MODULE F: BASIC RIGGING (Optional)

Effective manufacturing professionals demonstrate how to use basic rigging as needed in their role. The following accountability criteria are considered essential for students

in the mechatronics program of study.

1. Explain how ropes, chains, hoists, loaders, and cranes are used to move material and equipment from one location to another on a job site.
2. Describe inspection techniques and load-handling safety practices.
3. Explain the American National Standards Institute (ANSI) hand signals.
4. Complete Performance Tasks

MODULE G: BASIC COMMUNICATION SKILLS (SDE Requirement)

Effective manufacturing professionals demonstrate appropriate communication skills as needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Describe the communication, listening and speaking processes and their relationship to job performance.
2. Describe good reading and writing skills and their relationship to job performance
3. Demonstrate telephone and e-communication skills necessary in the workplace.
4. Complete Performance Tasks

MODULE H: BASIC EMPLOYABILITY SKILLS (SDE Requirement)

Effective manufacturing professionals demonstrate appropriate workplace behavior as needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Describe the opportunities in the construction business and how an individual enters the construction workforce.
2. Explain the importance of critical thinking and how to solve problems in the workplace.
3. Explain the importance of social skills and identify ways good social skills are applied in the construction trade.
4. Describe computer systems and their industry applications.
5. Explain interpersonal relationship skills, self-presentation, and key workplace issues such as sexual harassment, stress, and substance abuse.

Mechatronics 1, 2, 3, 4 are the minimum standards for articulation of Mechatronics to (some) technical colleges in South Carolina.

MECHATRONICS 1

AC-DC CIRCUITS /INDUSTRIAL SAFETY
(Safety standard is re-enforced in each section.)

Effective mechatronic professionals demonstrate appropriate industrial safety as

needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Explain the idea of a safety culture and its importance to mechatronics.
2. Identify causes of accidents and the impact of accident costs.
3. Explain the role of OSHA in job-site safety.*
4. Explain OSHA's General Duty Clause and 1926 CFR Subpart C.
5. Recognize hazard recognition and risk assessment techniques.
6. Explain fall protection and ladder, stair, and scaffold procedures and requirements.
7. Identify struck-by hazards.
8. Demonstrate safe working procedures and requirements related to lock out-tag out procedures.
9. Identify caught-in-between hazards.
10. Demonstrate safe working procedures and requirements related to caught-in-between hazards.
11. Demonstrate safe work procedures to use around electrical hazards.
12. Demonstrate the use and care of appropriate personal protective equipment (PPE).
13. Explain the importance of hazard communications (HazCom) and Safety Data Sheets (SDSs).
14. Identify other construction hazards on your job site, including hazardous material exposures, environmental elements, welding and cutting hazards, confined spaces, and fires.
15. Recognize what atoms are and how they are constructed.
16. Identify ways in which voltage can be produced.
17. Demonstrate the difference between conductors and insulators.
18. Define the units of measurement that are used to measure the properties of electricity.
19. Explain how voltage, current, and resistance are related to each other.
20. Calculate electrical quantities using Ohm's Law.
21. Calculate the amount of power used by a circuit.
22. Demonstrate understanding of capacitance and inductance in a DC circuit.
23. Construct a basic series circuit.
24. Construct a basic parallel circuit.
25. Construct a series-parallel combination circuit.
26. Calculate, using Kirchhoff's Voltage Law, the voltage drop and total current in series, parallel, and series-parallel circuits.
27. Measure the total amount of resistance in a series circuit.
28. Measure the total amount of resistance in a parallel circuit.
29. Measure the total amount of resistance in a series-parallel circuit.
30. Compare calculated and measured electrical properties.

MECHATRONICS 2

MECHANICAL COMPONENTS ELECTRIC DRIVES/HAND AND POWER TOOL OPERATIONS

Effective mechatronic professionals demonstrate appropriate skills for power tools operations as needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Illustrate use of basic hand and power tools (see tools and equipment list).
2. Use torque wrenches.
3. Describe the basic procedures for taking care of hand and power tools.
4. Use hand and power tools safely.
5. Demonstrate how to maintain hand and power tools properly.
6. Compare the use of threaded fasteners and non-threaded fasteners.
7. Demonstrate applications for fasteners and anchors.
8. Demonstrate use of precision measurement tools (English and metric).
   a. Use levels.
   b. Use feeler gauges.
   c. Use calipers.
   d. Use micrometers.
   e. Uses dial indicators.
   f. Use protractors.
   g. Use parallels and gauge blocks.
   h. Use precision straightedges.
   i. Use a standard ruler and a metric ruler to measure.
9. Evaluate the metric system and how it is important in mechatronics.
10. Use metric units of length, weight, volume, and temperature.
11. Convert English/standard to metric.
12. Demonstrate the ability to perform layout work to include the use of calipers, drills, height and depth gauges, and other measurement tools.
13. Demonstrate ability to install trouble shoot program AC/DC Drives (Allen Bradley/Siemens or appropriate companies)

MECHATRONICS 3

ELECTRO PNEUMATICS AND HYDRAULICS

Effective mechatronic professionals demonstrate appropriate usage of electro pneumatics and hydraulics as needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Demonstrate hydraulic system safety.
2. Explain the principles of hydraulics and hydraulic fluids.
3. Identify hydraulic components (supply elements, control valves, and actuators).
4. Explain hydraulic systems (forces, speed, friction, flow, and pressure).
5. Identify types of hydraulic pumps.
6. Identify types of hydraulic motors.
7. Demonstrate pneumatic safety.
8. Calculate the physical characteristics and compressibility of gases (Pascal's law

and Boyle's law).

9. Describe the pneumatic transmission of energy.
10. Identify types of compressors.
11. Analyze the principles of compressor operation and compressed-air treatment.
12. Construct pneumatic systems from components and symbols.
13. Demonstrate the ability to read, construct, and interpret fluid power symbols as well as fluid power diagrams.
14. Demonstrate correct installation and maintenance as well as preventive maintenance techniques for fluid power systems using service manuals.
15. Troubleshoot and repair fluid power systems using service manuals and gauges.

MECHATRONICS 4

DIGITAL FUNDAMENTALS AND PROGRAMMABLE CONTROLLERS
ADVANCED AC CIRCUITS

Effective mechatronic professionals demonstrate appropriate usage of electro pneumatics and hydraulics as needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Calculate the peak and effective voltage or current values for an AC waveform.
2. Calculate the phase relationship between two AC waveforms.
3. Measure the voltage and current phase relationship in a resistive AC circuit.
4. Describe the voltage and current transients that occur in an inductive circuit.
5. Define inductive reactance.
6. Describe the voltage and current transients that occur in a capacitive circuit.
7. Define capacitive reactance.
8. Construct circuits showing the relationship between voltage and current in the following types of AC circuits:
   a. RL circuit
   b. LC circuit
9. Describe the effect that resonant frequency has on impedance and current flow in a series or parallel resonant circuit.
10. Describe how bandwidth is affected by resistance in a series or parallel resonant circuit.
11. Describe the following terms as they relate to AC circuits:
    a) True power
    b) Reactive power
    c) Apparent power
    d) Power factor
12. Describe operation of a transformer.

ELECTRICAL TEST EQUIPMENT

Effective mechatronic professionals demonstrate appropriate knowledge and usage of electrical test equipment as needed in their role. The following accountability criteria are

considered essential for students in the mechatronics program of study.

1. Demonstrate the operation of the following pieces of test equipment: Utilized in sections1-4
   a) Ammeter
   b) Voltmeter
   c) Ohmmeter
   d) Multimeter*
   e) Frequency meter 4
   f) Oscilloscope 4
   g) Continuity tester
   h) Voltage tester

2. Represent results using engineering notation.

3. Understand the importance of proper meter polarity.

4. Demonstrate frequency using a frequency meter.

5. Compare the difference between digital and analog meters.

OPTIONAL ADVANCED STANDARDS:

The following may be required for dual credit at some SC technical colleges.

The following optional standards may be addressed if extra time allows but maybe required for dual credit.

PROGRAMMABLE LOGIC CONTROLLERS

Effective mechatronic professionals demonstrate appropriate knowledge and usage of programmable logic controllers as needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Describe the function and purpose of a programmable logic controller (PLC).
2. Compare hardwired and PLC systems.
3. Convert between number systems.
4. Analyze a binary logic network.
5. Describe the purpose of the various power supplies used within a PLC.
6. Construct input/output (I/O) circuits.
7. Define the function of the PLC processor module.
8. Describe the interrelations between microprocessor components.
9. State the characteristics of the different types of memory.
10. Demonstrate the features of relay ladder logic instruction categories.
11. Demonstrate the principles used to correlate PLC hardware components to

software instructions.
12. Convert a hardware ladder diagram to a PLC ladder diagram.
13. Program PLC using the converted PLC ladder diagram.
14. Troubleshoot problems in PLC circuit using a given diagram.

INTRODUCTION TO ROBOTICS SYSTEMS

Effective mechatronic professionals demonstrate appropriate knowledge and usage of robotics systems as needed in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

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

Effective mechatronic professionals demonstrate knowledge and usage of mechatronics concepts in their role. The following accountability criteria are considered essential for students in the mechatronics program of study.

1. Define the following terms:
   a) Ampacity
   b) Branch circuit
   c) Circuit breaker
   d) Controller
   e) Duty
   f) Equipment
   g) Full-load amps
   h) Ground fault circuit interrupter
   i) Interrupting rating
   j) Motor circuit switch
   k) Thermal protector
   l) NEMA design letter
   m) Nonautomatic
   n) Overcurrent
   o) Overload
   p) Power factor
   q) Rated full-load speed
   r) Rated horsepower
   s) Service factor
   t) Thermal cutout

u) Remote control circuit

2. Describe the various types of motor enclosures.
3. Describe how the rated voltage of a motor differs from the system voltage.
4. Describe the basic construction and components of a three-phase squirrel cage induction motor.
5. Explain the relationships among speed, frequency, and the number of poles in a three-phase induction motor.
6. Describe how torque is developed in an induction motor.
7. Explain how and why torque varies with rotor reactance and slip.
8. Define percent slip and speed regulation.
9. Explain how the direction of a three-phase motor is reversed.
10. Describe the component parts and operating characteristics of a three-phase wound rotor induction motor.
11. Describe the component parts and operating characteristics of a three-phase synchronous motor.
12. Define torque, starting current, and armature reaction as they apply to DC motors.
13. Explain how the direction of rotation of a DC motor is changed.
14. Describe the design and characteristics of a DC shunt, series, and compound motor.
15. Describe dual-voltage motors and their applications.
16. Describe the methods for determining various motor connections.
17. Describe general motor protection requirements as delineated in the National Electrical Code (NEC).

Equipment List:

Equipment list is not all-inclusive; school districts have various types of industries which may dictate additional equipment to meet area business and industry requirements.

Hydraulic Trainer or components

Pneumatic Trainer or components

Ammeter

Voltmeter

Multi-meter

Frequency Meter

Oscilloscope

Continuity Tester

Voltage Tester

Programmable Logic Controller Trainer or components

Robotics System Trainer or components

Motor Control System Trainer or components

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