

**Arkansas Department of Career Education
Model Framework**

Course Title: Pre-Mechatronics

Secondary – Skilled and Technical Sciences	
Course Number	
Career Cluster	Manufacturing
CIP Number	47.0303, 14.4201, 210000, 150400
Grade Level	10-12
Course Credit	1 unit
Course Type	Core
Teacher Certification	577/583/585/586/587/593/616/621
CTSO	SkillsUSA
Facility Requirements	http://arkansasfacilities.arkansas.gov/facilities/academic-facilities-manual
Industry Certifications	http://nccer.org

Course Description

Mechatronics is an applied course in the manufacturing cluster for students interested in learning more about careers as a mechatronics technician, maintenance technician, electromechanical technician, and manufacturing engineer. This course covers basic electrical and mechanical components of mechatronics systems with instrument controls and embedded software designs. Manufacturing Technology (Mechatronics) teaches the design, building, and maintaining of equipment that combines electronics, mechanics, pneumatics, hydraulics, and computer control systems. Upon completion of this program proficient students are able to describe and explain basic functions of physical properties and electrical components within a mechatronic system. They can logically trace the flow of energy through a mechatronic system and can communicate this process to others. They know how to effectively use technical documentation such as data sheets, schematics, timing diagrams, and system specifications to troubleshoot basic problems with equipment.

Mechatronics is a multi-disciplinary study to develop specialized and highly trained technicians dealing with the integration of mechanical devices, actuators, sensors, electronics, intelligent controllers and computers. Many new generations of consumer or commercial products can be classified as mechatronic products as they involve mechanical as well as electronic components. The need for mechatronic education has grown due to the increase in the number and importance of such systems and devices.

Mechatronics technicians set up and maintain robotic equipment, automated manufacturing equipment, treatment plant equipment, programmable logic controllers, and any hybrid production or test equipment. These specialized technicians will meet a current and future need for local, area-wide, and global manufacture needs. Mechatronics technicians need a broad understanding of how mechanical and electrical energy is produced, controlled and utilized.

Purpose

This is a foundation course to introduce students to postsecondary programs in electronics, manufacturing, and technical programs designed to develop skilled installation, maintenance and repair technicians in cross disciplinary systems. This course will introduce students to the industry technical skills including:

- Design and Development
- Operations
- Maintenance, Installation and Repair
- Quality Assurance and Improvement
- Health, Safety and Security

Standard 1.0 Identify and demonstrate understanding of industrial equipment maintenance and mechatronics			
Performance Indicator 1.1 Demonstrate an understanding of mechatronics and industrial equipment maintenance crafts.	Recommended Application/Activity	CCSS Standards	CCTC Standards
1.1.1 Describe the types of work performed by industrial maintenance and mechatronics craft workers.	<ul style="list-style-type: none"> • MODULE 32101 • Apply mechatronics in various manufacturing, scientific, and technical applications. 		
1.1.2 Identify career opportunities available to industrial maintenance and mechatronics craft workers.	<ul style="list-style-type: none"> • 		
1.1.3 Explain the purpose and objectives of an apprenticeship training program.	<ul style="list-style-type: none"> • 		
1.1.4 Explain the responsibilities and characteristics of a good industrial maintenance and mechatronics craft worker.	<ul style="list-style-type: none"> • Explain the time factor in industrial processing. • Explain the human element and the skills needed in mechatronics. 		
1.1.5 Explain the importance of safety in relation to industrial maintenance and mechatronics craft workers.	<ul style="list-style-type: none"> • Explain the necessity for electrical, mechanical and industrial safety rules are necessary. • Discuss the Material Safety Data Sheets (MSDS) Right-to-Know Law. • Identify proper ventilation, lighting, heating, grounding, clothing, and communication requirements in confined spaces. 		
1.1.6 Explain the role of NCCER in the training process.	<ul style="list-style-type: none"> • 		
1.1.7 Explain how mechatronics is the integration of multiple disciplines in industrial process.	<ul style="list-style-type: none"> • 		
1.1.8 Describe the flow of electrical and mechanical energy in a mechanical system.	<ul style="list-style-type: none"> • 		
Performance Indicator 1.2 Explain the inter-relationships of components and modules within a complex mechatronic system.	Recommended Application/Activity	CCSS Standards	CCTC Standards

1.2.1 Trace the historical development of the four facets (mechanical systems, electronic systems, computer systems, and control systems) of a mechatronic system.	<ul style="list-style-type: none"> • Explain their chief applications in modern society, citing specific textual evidence. 		
1.2.2 Demonstrate understanding of the specific role of various mechanical components in mechatronic systems, discerning in a system schematic the effects of various design parameters.	<ul style="list-style-type: none"> • 		
1.2.3 Describe the necessary steps to plan, execute, and control a mechatronic system.	<ul style="list-style-type: none"> • 		
1.2.4 Explain how mechatronics is the integration of multiple disciplines in industrial processes.	<ul style="list-style-type: none"> • 		
1.2.5 Identify major application areas for mechatronics.	<ul style="list-style-type: none"> • 		
Performance Indicator 1.3 The student will demonstrate an understanding of the National Electric Code®.	Recommended Application/Activity	CCSS Standards	CCTC Standards
1.3.1 Explain the purpose of the National Electrical Code® (NEC®).			
1.3.2 Describe the layout of the NEC®.	<ul style="list-style-type: none"> • 		
1.3.3 Explain how to navigate the NEC®.	<ul style="list-style-type: none"> • 		
1.3.4 Describe the purpose of the National Electrical Manufacturers' Association (NEMA) and the National Electric Code.	<ul style="list-style-type: none"> • 		
1.3.5 Explain the role of testing laboratories.	<ul style="list-style-type: none"> • 		

Standard 2.0 Identify and demonstrate an understanding of the tools used in manufacturing and electronics.			
Performance Indicator 2.1 The student will demonstrate an understanding of tools of the trade.	Recommended Application/Activity	CCSS Standards	CCTC Standards
2.1.1. Explain the purpose of each of the tools commonly used by industrial maintenance and mechatronics workers.	<ul style="list-style-type: none"> MODULE 32102 		
2.1.2 Describe how to maintain each of the tools used by industrial maintenance and mechatronics craft workers.	<ul style="list-style-type: none"> 		
2.1.3 Demonstrate the proper use and basic maintenance of selected industrial maintenance and mechatronics tools.	<ul style="list-style-type: none"> 		
Performance Indicator 2.2 The student will demonstrate an understanding of fasteners and anchors.	Recommended Application/Activity	CCSS Standards	CCTC Standards
2.2.1 Identify and explain the use of threaded fasteners.	<ul style="list-style-type: none"> MODULE 32103 		
2.2.2 Identify and explain the use of non-threaded fasteners.	<ul style="list-style-type: none"> 		
2.2.3 Identify and explain the use of anchors.	<ul style="list-style-type: none"> 		
2.2.4 Select the correct fasteners and anchors for given applications.	<ul style="list-style-type: none"> Install fasteners and anchors. 		
Performance Indicator 2.3 The student will demonstrate an understanding of test equipment.	Recommended Application/Activity	CCSS Standards	CCTC Standards
2.3.1 Explain the operation of and describe the following pieces of test equipment: <ul style="list-style-type: none"> Tachometer Pyrometers Multimeters Automated diagnostics tools Wiggy® voltage tester Stroboscope 	<ul style="list-style-type: none"> MODULE 32110 		

2.3.2 Explain how to read and convert from one scale to another using the above test equipment.	•		
2.3.3 Define frequency and explain the use of a frequency meter.	•		
Standard 3.0 Demonstrate an understanding of health and safety procedures in a manufacturing environment.			
3.1 Understand Occupational Safety and Health Administration (OSHA) safety rules.			
3.1.1 Explain the necessity for electrical, mechanical and industrial safety rules.	•		
3.1.2 Demonstrate understanding of Material Safety Data Sheets and the right-to-know laws.	•		
3.1.3 Identify proper ventilation, grounding, clothing, and communication requirements.	•		
3.1.4 Identify industrial safety codes, standards and regulations.	•		
3.1.5 Explain OSHA hazard communication as pertaining to lubrication. Read and interpret a material data safety sheet (MSDS).	•		
3.1.6 Explain the EPA hazardous waste control program.	•		
3.2 Apply safety procedures of electronic instruments.			
3.2.1 Demonstrate appropriate use of tools and equipment.	•		
3.2.2 Explain fire prevention and extinguishing of mechanical and electrical fires.	•		
3.2.3 Demonstrate knowledge of communicating safety violations.	•		
3.2.4 Identify procedures for emergency evacuations.	•		

3.2.5 Identify causes of accidents and the impact of employee accidents on the employer and industry.	•		
3.2.6 Identify basic crane, forklift and loading safety procedures.	•		
Standard 4.0 Identify and demonstrate an understanding of craft-related mathematics and blueprints			
Performance Indicator 4.1 The student will demonstrate an understanding of craft-related mathematics and schematic diagrams.	Recommended Application/Activity		CCSS Standards
	CCTC Standards		
4.1.1 Identify and explain the use of special measuring devices.	<ul style="list-style-type: none"> • MODULE 32106 • Use tables of weights and measurements. • Use formulas to solve basic problems • Solve area problems. • Solve volume problems. • Solve circumference problems. • Solve right triangles using the Pythagorean theorem. 		
4.1.2 Explain the basic layout of a mechanical or electrical diagram.	<ul style="list-style-type: none"> • MODULE 32107 • Describe the information included in the title block of a blueprint. 		
4.2.3 Identify common symbols used on a diagram legend.	•		
4.2.4 Analyze basic mechatronic blueprints.	• Demonstrate the use of an architect's scale.		

Standard 5.0 Identify and demonstrate an understanding of mechanical components and systems.			
Performance Indicator 5.1 The student will demonstrate an understanding of pumps and valves.	Recommended Application/Activity	CCSS Standards	CCTC Standards
5.1.1 Identify and explain centrifugal pumps, rotary pumps, reciprocating pumps, metering pumps and vacuum pumps.	<ul style="list-style-type: none"> MODULE 32108 		
5.1.2 Explain net positive suction head and cavitation.			
5.1.3 Identify types of drivers.			
5.1.4 Identify types of valves that start and stop flow, valves that regulate flow, valves that relieve pressure and valves that regulate the direction of flow.	<ul style="list-style-type: none"> MODULE 32109 		
5.1.5. Explain valve locations and positions to properly store and handles.	<ul style="list-style-type: none"> 		
Performance Indicator 5.2 Demonstrate an understanding of gaskets and packing materials.	Recommended Application/Activity	CCSS Standards	CCTC Standards
5.2.1 Identify the various types of gaskets and explain their uses.	<ul style="list-style-type: none"> MODULE 32105 		
5.2.2 Identify the various types of gasket materials and explain their applications.	<ul style="list-style-type: none"> Lay out, cut, and install a flange gasket 		
5.2.3 Describe the use of O-rings.	<ul style="list-style-type: none"> 		
5.2.4 Explain the importance of selecting the correct O-ring for an application.	<ul style="list-style-type: none"> Select an O-ring for a given application and install it. 		
Performance Indicator 5.3 Demonstrate an understanding of lubrication materials and processes.	Recommended Application/Activity	CCSS Standards	CCTC Standards
5.3.1 Explain lubricant storage, classification, film protection, properties of lubricants, properties of greases, how to select lubricants.	<ul style="list-style-type: none"> MODULE 32113 		

5.3.2 Identify and explain types of additives and of lubricating oils.	<ul style="list-style-type: none"> Identify and use lubrication equipment to apply lubricants. 		
5.3.3 Read and interpret a lubrication chart.			
Performance Indicator 5.4 Demonstrate an understanding of material handling, rigging, and support equipment.	Recommended Application/Activity	CCSS Standards	CCTC Standards
5.4.1 Identify and describe the uses of common rigging hardware and equipment.	<ul style="list-style-type: none"> MODULE 32111 Inspect common rigging equipment. Select, use, and maintain special rigging equipment, including: <ul style="list-style-type: none"> Jacks Block and tackle Chain hoists Come-alongs Tie knots used in rigging.		
5.4.2 State the safety precautions associated with the use of motor-driven equipment in industrial plants.	<ul style="list-style-type: none"> MODULE 32112 		
5.4.3 Explain the operation and applications of the following motor-driven equipment commonly used in industrial plants.	Operate and perform preventive maintenance on the following equipment: <ul style="list-style-type: none"> Portable generators Air compressors Aerial lifts 		
Performance Indicator 5.5 The student will demonstrate an understanding of oxyfuel cutting processes.	Recommended Application/Activity	CCSS Standards	CCTC Standards
5.5.1 Identify and explain the use of oxyfuel cutting equipment.	<ul style="list-style-type: none"> MODULE 32104 		
5.5.2 State the safety precautions for using oxyfuel equipment.	Set up oxyfuel cutting equipment. Light and adjust an oxyfuel torch. Shut down oxyfuel cutting equipment. Disassemble oxyfuel cutting equipment. Change empty cylinders. Perform oxyfuel cutting:		

	<ul style="list-style-type: none"> • Straight line and square shapes • Piercing and slot cutting • Bevels • Washing <p>Apply a rosebud flame to remove frozen components (also for preheat and expanding larger fittings). Operate a motorized, portable oxyfuel gas cutting machine.</p>		
6.0 Analyze education and career related opportunities.			
6.1 Investigate occupations in manufacturing processes that rely on electromechanical principles and technologies.			
6.1.1 Demonstrate an understanding of career opportunities and requirements in the field of mechatronics.			
6.1.2 Discuss individual interests related to a career in electronics technology.			
6.1.3 Determine knowledge, skills and abilities required for careers in mechatronics.			
6.2 Explore education and training opportunities related to a career in the mechatronics pathway.			
6.2.1 Develop a career plan with alternatives with multiple exit points to include stackable credentials.			
6.2.2 Develop a career ladder including education programs, extended learning opportunities, foundation work plans and career goals.			
6.3 Develop employability skills to secure and keep employment in chosen field.			
6.3.1 Conduct a job search for possible career opportunities to determine industries,			

locations, and job opportunities.			
6.3.2 Complete a job application form correctly.			
6.3.3 Develop a career portfolio including examples of work, awards, letters of recommendation and recognition.			

Common Core State Standards Grades 9-12

ELA Speaking and Listening Standards Grades 9-10

1. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL9-10.1**
 - a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. **SL9-10.1a**
 - b. Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed. **SL9-10.1b**
 - c. Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions. **SL9-10.1c**
 - d. Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented. **SL9-10.1d**
2. Integrate multiple sources of information presented in diverse media or format(e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source. **SL9-10.2**
3. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any fallacious reasoning or exaggerated or distorted evidence. **SL9-10.3**
4. Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task. **SL9-10.4**
5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. **SL9-10.5**

ELA Language Grades 9-10

4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 9–10 reading and content, choosing flexibly from a range of strategies. **L9-10.4**
 - a. Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase. **L9-10.4a**
 - b. Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., analyze, analysis, analytical; advocate, advocacy). **L9-10.4b**

- c. Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, or its etymology. **L9-10.4c**
 - d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary). **L9-10.4d**
6. Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. **L9-10.6**

Reading Standards for Literacy in Science and Technical Subjects Grades 9-10

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. **R9-10.1**
2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. **R9-10.2**
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. **R9-10.3**
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics. **R9-10.4**
5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy). **R9-10.5**
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address. **R9-10.6**
7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. **R9-10.7**
8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. **R9-10.8**
9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. **R9-10.9**
10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently. **R9-10.10**

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects Grades 9-10

1. Write arguments focused on discipline-specific content. **W9-10.1**
 - a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. **W9-10.1a**
 - b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. **W9-10.1b**
 - c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. **W9-10.1c**
 - d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. **W9-10.1d**
 - e. Provide a concluding statement or section that follows from or supports the argument presented. **W9-10.1e**
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **W9-10.2**
 - a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. **W9-10.2a**
 - b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. **W9-10.2b**
 - c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. **W9-10.2c**
 - d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. **W9-10.2d**
 - e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. **W9-10.2e**
 - f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). **W9-10.2f**
3. Write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results. **W9-10.3**
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **W9-10.4**
5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. **W9-10.5**
6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. **W9-10.6**

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. **W9-10.7**
8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. **W9-10.8**
9. Draw evidence from informational texts to support analysis, reflection, and research. **W9-10.9**
10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences. **W9-10.10**

Common Career and Technical Core Standards

Maintenance, Installation, & Repair Career Pathway (MN-MIR)

1. Demonstrate maintenance skills and proficient operation of equipment to maximize manufacturing performance.
2. Demonstrate the safe use of manufacturing equipment to ensure a safe and healthy environment.
3. Diagnose equipment problems and effectively repair manufacturing equipment.
4. Investigate and employ techniques to maximize manufacturing equipment performance.
5. Implement a preventative maintenance schedule to maintain manufacturing equipment, tools and workstations.
6. Implement an effective, predictive and preventive manufacturing equipment maintenance program.

Manufacturing Production Process Development Career Pathway (MN-PPD)

1. Produce quality products that meet manufacturing standards and exceed customer satisfaction.
2. Research, design and implement alternative manufacturing processes to manage production of new and/or improved products.
3. Monitor, promote and maintain a safe and productive workplace using techniques and solutions that ensure safe production of products.
4. Implement continuous improvement processes in order to maintain quality within manufacturing production.
5. Develop procedures to create products that meet customer needs.

Production Career Pathway (MN-PRO)

1. Diagnose production process problems and take corrective action to meet production quality standards.
2. Manage safe and healthy production working conditions and environmental risks.
3. Make continuous improvement recommendations based on results of production process audits and inspections.
4. Coordinate work teams when producing products to enhance production process and performance.
5. Demonstrate the safe use of manufacturing equipment.

Engineering & Technology Career Pathway (ST-ET)

1. Use STEM concepts and processes to solve problems involving design and/or production.
2. Display and communicate STEM information.
3. Apply processes and concepts for the use of technological tools in STEM.
4. Apply the elements of the design process.
5. Apply the knowledge learned in STEM to solve problems.
6. Apply the knowledge learned in the study of STEM to provide solutions to human and societal problems in an ethical and legal manner.

Career Ready Practices

1. Act as a responsible citizen in the workplace and the community. (CRP1)
2. Apply appropriate technical skills and academic knowledge. (CRP2)
3. Practice personal health and understand financial literacy. (CRP3)
4. Communicate clearly, effectively, and with reason. (CRP4)
5. Understand the environmental, social, and economic impacts of decisions. (CRP5)
6. Demonstrate creativity and innovation. (CRP6)
7. Employ valid and reliable research strategies. (CRP7)
8. Utilize critical thinking to make sense of problems and persevere in solving them. (CRP8)
9. Model integrity, ethical leadership, and effective management. (CRP9)
10. Develop an education and career plan aligned to personal goals. (CRP10)
11. Apply technology to enhance productivity. (CRP11)
12. Work productively in teams while integrating cultural/global competence. (CRP12)