



2024-2025

Mechatronics 2

COURSE OUTLINE - UC

DESCRIPTION:

Mechatronics is the designing and manufacturing of products with electronic components and is used to develop major systems as well as day-to-day devices such as smartphones and household machines. Mechatronics 2 is designed to equip students with entry-level technical and service repair skills for supporting the installation, troubleshooting, and maintenance of equipment in the mechatronics and advanced manufacturing industry. Students will perform simple operations using robotic and autonomous systems to gain a fundamental understanding of programmable logic controllers (PLCs), wireless communication, electrical motors and motor controllers, pneumatics/hydraulics, as well as advanced electricity. By employing an interdisciplinary approach of reading, writing, problem solving, and hands-on projects students will acquire practical skills and industry knowledge for entry-level employment in mechatronics/advanced manufacturing, including Industry 4.0 production settings, and SACA (Smart Automation Certification Alliance) C-101 Certified Industry 4.0 Associate I – Basic Operations silver certificate. Students passing the SACA C-101 silver certificate qualify to perform SACA C-101 assessments for the gold certificate. Activities in this course include work-based learning that connect students to industry and the local community.

INFORMATION:

PRE-REQUISITE:	Mechatronics 1
LENGTH:	One Year
SECTOR:	Manufacturing and Product Development
PATHWAY:	Product Innovation and Design Pathway
ARTICULATED:	Yes
UC A-G APPROVAL:	Yes: College-Preparatory Elective (G) – Laboratory Science – Integrated Science Requirement

O*NET SOC CODES:

17-3028	Calibration Technologists and Technicians
17-3024	Robotic Technicians
49-2091	Industrial Machinery Mechanics
51-4011	Computer-controlled machine tool operators, metal and plastic
51-4041	Machinists

Orientation
<ul style="list-style-type: none">A. Introduce the course and facilities.B. Discuss the syllabus and major objectives.C. Explain applicable classroom management procedures, and any operational guidelines.D. Review instructor/student expectations.E. Explain attendance requirements and procedures.F. Review grading and student evaluation procedures.G. Discuss the work-based learning aspect of the program, if applicable.H. Discuss the “next steps” related to additional education, training, and employment.I. Review classroom safety, emergency and disaster procedures.
1. Communication Skills
<ul style="list-style-type: none">A. Demonstrate positive verbal communication skills using appropriate vocabulary, demeanor, and vocal tone in the classroom and/or worksite.B. Read and interpret written information and directions.C. Practice various forms of written communication appropriate to the occupation.D. Practice positive body language skills.E. Practice professional verbal skills for resolving a conflict.F. Demonstrate active listening skills including techniques for checking for understanding, and for obtaining clarification of directions.
2. Interpersonal Skills
<ul style="list-style-type: none">A. Demonstrate positive teamwork skills by contributing to a group effort.B. Practice the importance of diversity awareness and sensitivity in the workplace.C. Define sexual harassment in the workplace and identify the employee’s role and responsibility.D. Practice participation skills.E. Identify different personality types and demonstrate flexibility and adaptability working with diverse individuals.F. Practice business and social etiquette skills appropriate to the occupation.G. Evaluate and discuss the role of business and personal ethics in decision making based on various job-related scenarios.H. Demonstrate the use of time management skills.
3. Employability Skills
<ul style="list-style-type: none">A. Demonstrate appropriate attendance and punctuality practices for the classroom (and worksite, if applicable).B. Prepare a resume, cover letter, and job application.C. Demonstrate interviewing techniques in seeking employment, using appropriate tone, body language and professional dress and

grooming standards.

- D. Identify strategies for employment retention.
- E. Identify and analyze sources of job information, including electronic sources and the impact of social networking on employability.
- F. Identify the need for continuing education, professional development, and professional growth in chosen field.
- G. Identify appropriate procedures for leaving a job.
- H. Review company policies and current trends in employee compatibility screening, drug screening, and background checks.

4. Leadership

- A. Define leadership and identify the responsibilities, competencies, and behaviors of successful leaders.
- B. Work with peers to promote divergent and creative perspectives.
- C. Demonstrate how to organize and structure work, individually and in teams, for effective performance and the attainment of goals.
- D. Explain multiple approaches to conflict resolution and their appropriateness for a variety of situations in the workplace.
- E. Employ ethical behaviors and actions that positively influence others.
- F. Analyze the short-term and long-term effects a leader's actions and attitudes can have on productivity, morale, and organizational culture.

5. Personal and Occupational Safety

- A. Demonstrate procedures to be followed in case of emergencies.
- B. Describe and discuss the procedure for reporting a work-related hazard or injury (worker's comp), including ways to report a potential safety hazard to a supervisor.
- C. Identify and discuss cyber ethics, cyber safety, and cyber security.
- D. Apply personal safety practices to and from the job.
- E. Recognize the effects of substance abuse in the workplace.
- F. Explain the importance of CAL-OSHA in the industry.

6. Mechatronics & Professionalism

- A. Define mechatronics and its role in product development and manufacturing.
- B. Track the evolution of mechatronics and its impact on society.
- C. Identify major inventions that affect daily life made through mechatronics.
- D. Research mechatronics career pathways and positions associated with various fields, in particular manufacturing.
- E. List the most important skills for mechatronics professionals.
- F. Research education, certifications, and wage requirements for entry-level jobs in mechatronics careers.
- G. Explain the importance of professional development and continuing education.
- H. Describe personal traits and work values for successful employment as a mechatronics professional.
- I. Recognize the proper appearance and communication style for workers.

- J. List the steps for self-care and emotional wellness.

7. Shop Safety / OSHA-10 Certification

- A. Demonstrate proper safety precautions when using various hand, power, and machine tools.
- B. Demonstrate the proper selection, use, inspection and maintenance of hand, power and machine tools and various equipment.
- C. Review employee rights and employer duties under CAL-OSHA.
- D. Identify the priorities and process for an OSHA inspection.
- E. Demonstrate knowledge of electrical hazards and other workplace hazards, and how to prevent them.
- F. Describe procedures for proper handling, storing, and disposing of hazardous waste, chemicals and flammable materials in accordance with local, state, and federal safety and environmental regulations.
- G. Wear appropriate personal protection equipment (PPE) and understand the limitations of PPE.
- H. Recognize effective strategies to prevent heat illness.
- I. Demonstrate knowledge of material safety data sheets (MSDS).
- J. Demonstrate proper housekeeping, including OSHA principles of fire prevention for a safe workplace.
- K. Demonstrate emergency preparedness by following posted evacuation routes and Emergency Action Plans (EAP).
- L. Apply lockout/tagout procedures correctly and safely. (OSHA)
- M. Describe first aid procedures including treatment for fires, hazardous materials, and accidents.
- N. Pass safety tests for OSHA-10 certification.

8. Design Process

- A. Explain the purpose of the 5 steps of the engineering method.
- B. Identify and define the problem/need.
- C. Generate ideas and concepts.
- D. Design a solution.
- E. Identify materials, costs, mechanisms, technologies, and other requirements the concepts may require.
- F. Build a looks-like, works-like prototype using the appropriate techniques or technologies.
- G. Assess prototype and make improvements as needed.
- H. Create a presentation of the design solution.
- I. Update portfolio.

9. Fluid Power Circuits (Pneumatic / Hydraulics)

- A. Describe the components of actuators.
- B. Identify compressors and conditioners.
- C. Describe fittings and hoses.
- D. Identify gauges and instruments.

- E. Recognize the various types and purpose of filters.
- F. Explain Electro-Fluid power and define the pump systems.
- G. Examine motors, various valves, and connectors.
- H. Demonstrate knowledge of various valves.
- I. Examine motors used in these systems.

10. AC/DC

- A. Define inductance and capacitance.
- B. Calculate inductance and capacitance.
- C. Differentiate three-phase from a single phase power.
- D. Hook up an inductor and capacitor in a DC and AC circuit.
- E. Hook up a combination circuit and solve for voltage, current, and equivalent resistance.
- F. Connect and operate a rheostat, voltage divider, and transformer.
- G. Design circuits on breadboards to model each type of circuit.
- H. Use a multimeter to verify voltage and current through a device.

11. Electric Control Logic / Intro to Electronic Components

- A. Demonstrate proper safety precautions when using electronic equipment and tools.
- B. Demonstrate the proper use of a multi-meter.
- C. Explain the difference and application of alternating current (AC) and direct current (DC).
- D. Demonstrate the use of logic elements including AND, OR, NOT, NOR, NAND, and MEMORY.
- E. List the sequence of operation of an electric control system.
- F. Analyze and interpret a schematic of an electric control system.
- G. Calculate power usage and size circuit protection.
- H. Compare and contrast conductors and insulators.
- I. Construct and install regulated power supplies.
- J. Select and install fuses and circuit breakers.
- K. Select and install power conditioning, isolation transformers, surge suppressors, uninterruptible power supplies.

12. Programmable Logic Control & Wireless Control

- A. Describe the advantages and disadvantages of using a PLC.
- B. Describe the six basic components of a PLC.
- C. Wire input/output devices to the PLC and operate the PLC.

- D. Control multiple outputs.
- E. Create ladder diagrams illustrating the function of the PLC program.
- F. Recognize PLC timer and counter concepts.
- G. Describe the basic principles of wireless communication including frequency bands, transmitters, and receivers.
- H. Define wireless communication technologies in cellular networks, Wifi, Bluetooth and InfraRed.
- I. Discuss the uses of RFID and differentiate between an active and passive RFID tag.
- J. Examine how to interface a PLC to a machine controller.
- K. Program wireless communication between devices.
- L. Create a remote control.
- M. Troubleshoot control systems.

13. Micro controllers

- A. Describe robots currently used in various industries such as health, manufacturing, defense, and more.
- B. Describe the different components of a robotic work cell.
- C. Apply sensors to sense movement.
- D. Demonstrate working knowledge of micro controllers.
- E. Identify micro-controllers and describe basic components of micro-controllers.
- F. Recognize the relationship between the functioning of the components to robotic control systems.
- G. Program micro controllers to perform simple operations.
- H. Examine how to interface a sensor with a sink or source output.
- I. Interface a device with a sink or source output.

14. DC/AC Motors and Motor Drivers

- A. Recognize DC/**AC** motors, stepper, gear, servo and linear actuator.
- B. Identify properties and function of AC and DC drivers.
- C. Describe the component and function of a DC/**AC** motor.
- D. Define torque, pressure, work, and power.
- E. Identify equations of torque, pressure, work, and power.
- F. Identify torque based on measurements.
- G. Define and calculate motor efficiency.
- H. Describe the operation, wiring and schematic symbols for **AC/DC** motors.

15. Introduction to Programming

- A. Describe basic concepts of programming.

- B. Acquire basic knowledge of programming languages used in the industry.
- C. Demonstrate how to copy codes from free sources of code.
- D. Apply knowledge of circuits to sequence, conditionals, variables, and loops.
- E. Recognize the basic principles of micro-controllers to control devices.
- F. Program sensors to control Arduino bot.
- G. Mount and wire sensors to work with Arduino bot.
- H. Troubleshoot.

16. Automation and Robotics

- A. Demonstrate proper safety precautions when using Amatrol Pegasus robotics.
- B. Design and program a robot using basic commands.
- C. Identify common robot characteristics and types used in manufacturing.
- D. Describe roll angle.
- E. Analyze factors that impact robots in a manufacturing environment.
- F. Describe robot components including drive systems and electrical components.
- G. Describe how robot geometry affects robot motion.
- H. Control robot manually with a teach pendant.
- I. Identify elements of a robotic program.
- J. Design and fabricate a digital I/O interface for a robot.
- K. Troubleshoot robot.

17. Certifications/Pre-Apprenticeship

- A. Demonstrate knowledge for OSHA-10 Certification – S/P2
- B. Develop Amatrol's Certified Production Technician skills.
- C. Prepare for SACA (Smart Automation Certification Alliance) C-101 Certified Industry 4.0 Associate I – Basic Operations silver certificate.
- D. Recognize hands-on assessments relative to SACA C-101 Certified Industry 4.0 - Basic Operations gold certificate.
- E. Demonstrate readiness for Pre-Apprenticeship opportunity.

18. Portfolio

- A. Develop personal marketing and computer skills by refining your digital portfolio for post-secondary and employment acceptance.
- B. Compile best samples of original works (in photographs and video) and documents for a variety of purposes, which shows a progression in the acquisition of knowledge and/or skills.
- C. Demonstrate knowledge of competencies through journaling or summary of selected works or documents.
- D. Revise professional resume and cover letter to align with skills and objective statements of the relevant industry.
- E. Dress professionally and practice interviewing techniques using portfolio materials.

- F. Assemble industry and employability documents (resume, cover letter, certifications, recommendation letters, etc.).
- G. Create a “leave behind” book or folder.
- H. Display portfolio materials during a fair, community event, competition, or professional panel review.
- I. Evaluate and utilize feedback to improve portfolio.

Assignment	Competencies	Career Ready Practices	Anchor Standards	Pathway Standards	CCSS
1. Students will participate in mock interviews that represent current industry practices (e.g., skills demonstrations, resumes, applications, portfolios, personal websites, etc.).	1 3 17 18	2 3 10	2 3		LS 11-12.6 SLS 11-12.2
2. In groups, students will research and present to class, major developments in the manufacturing and mechatronics industry by focusing on a specific product or industry (manufacturing, medicine, defense, space, agriculture, automotive, etc.) and identifying the people, machines, technologies, processes, costs, and societal changes that have impacted or propelled the change.	6	11 12	2	D 2.0	W 11-12.4 W 11-12.7
3. Students will participate in a simulation exercise where they respond to an emergency and create an emergency response plan for the lab in which students will identify potential emergency scenarios, outline response procedures and roles of students. Students will demonstrate knowledge of safety skills while completing tasks that pertain to certification(s) and pre-apprenticeship opportunities including OSHA-10 certification. Amatrol Skill Boss 95-MSB2AB / Amatrol Hand Tools for Skill Boss / Amatrol Mechanical Fabrication 950-MPF1.	1 3 7 17	2 6 8	2 6 7	D1	SLS 11-12.1 SLS 11-12.1b
4. Create an invention and design report that focuses on the problems encountered, how each team worked through each problem, the bill of materials that were used to build the project, and an explanation of why the final design was chosen. Students will then sell their product via a group sales presentation.	1 2 4 8	2 9	2 9	D 10.0	SL 11-12.1 SL 11-12.4 SL 11-12.5 W 11-12.4
5. Students will hook up a pressure regulator, filter, quick connect hoses, and couplings. Students will transfer air	5 9	1 4	4 10	B5.0 B6.0	CC 5 SEP 1-5, 8

<p>pressure from one device to another using a 3-way directional control valve, two pistons, and a pneumatic motor. Students will calculate the output force and retracting force of an extending cylinder, verify Pascal's law, calculate pressure and volume problems using Boyle's Law, and calculate the pressure difference in a system across multiple components. Further, students will create a working hydraulic arm from wood or steel to pick up 2 objects of different sizes and weights.</p> <p>Amatrol 950-HTB1; Amatrol 990-PN1</p>					
<p>6. Students will review electrical skills on Amatrol's AC/DC Electrical Learning System T7017A. Students will create an electrical circuit powered by solar or windmill.</p> <p>Amatrol's AC/DC Electrical Learning System T7017A</p>	10	1 4 9	4 5 9 10	D1.0 D2.0 D3.0 B3.0 B5.0	CC 2 CC 5 PS 3.C SEP 1-8
<p>7. Students will identify the components of a Rockwell Micro800 series PLC and use a Rockwell CCW software program to create a PLC project: Students will work in small groups to connect various logic elements including AND, OR, NOT, NOR, NAND, and MEMORY logic. Students will progress to more advanced systems such as pneumatic solenoids, timers, and relays. Students will draw electrical control schematics for those circuits.</p> <p>Students will design a continuous cycle cylinder reciprocation circuit with a safety interlock. Students must be able to correctly wire 2 push buttons, 2 relays, 2 LED indicator lights, 4 limit switches, 2 pneumatic valves, and a safety "drop-dead switch" for 2 cylinders that reciprocate back and forth. Students will produce a schematic of the circuit they produce.</p> <p>Amatrol Applied Electrical Control 90-EC1A / Micro controllers: Amatrol Portable electronic sensor Learning System 990-SN1</p>	10 11 12 13	1 4 9	4 5 9 10	D1.0 D2.0 D3.0 B3.0 B5.0	CC 2 CC 5 PS 3.C SEP 1-8

<p>8. Students will work with/program Arduinos and Amatrol Pegasus Robotics Learning System: Students will turn in codes to control AC/DC motor. Further, given a Pegasus Robotic Arm, students will control the robot manually with a teach pendant. Students will move material from one point to another by programming the robot. Students will finish by interfacing the robot with other devices to unload an automatic machine through multiple input and output devices.</p> <p>Amatrol Pegasus Robotics 96 ROB1A Learning System</p>	<p>5 13 14 15 16</p>	<p>1 4 5</p>	<p>4 5 10</p>	<p>B8.0</p>	<p>SEP 1, 3-6</p>
<p>9. Students will work on teams for a highway and bridge construction company. New construction on a bridge will not be complete for at least 10 years so students must design an interim bridge that will accommodate both road and waterway traffic. The drawbridge must be able to span 28 inches, be at least 6 inches wide, and have a mechanical efficiency of 100. The project must have a traffic light with 1 red and 1 green light. The light must turn red for 10 seconds before the drawbridge begins to lift. Students must hook up non-contact sensors that will detect the height of each boat that goes under the drawbridge. These sensors must only activate when a boat is too big to fit under the drawbridge. The students must wire the circuit that is designed on the breadboard with the PLC to control the operation. The PLC must also control a buzzer that will go off before the drawbridge rises and will provide barriers to the traffic. The barriers and the red light will not be able to turn off until the bridge is lowered. The project must have a pneumatically powered drawbridge that will be lifted slowly at first, then more quickly to prevent jolting. In the opposite direction, it must be lowered quickly at first then more slowly as the drawbridge closes back up. Boats must be transported onto the river (conveyor belt) using a vacuum system to carry them to prevent any damage to the outside hull of the boat. The boats must be various sizes and created in a CNC machine.</p>	<p>2 4 7-18</p>	<p>5 10</p>	<p>2 5 9</p>	<p>D 1.0 D 3.0</p>	<p>SL 11-12.1</p>

Standards Assessed in this Program

Career Ready Practices

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

Anchor Standards

2.0 Communications

- Acquire and use accurately sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats.

3.0 Career Planning and Management

- Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans.

4.0 Technology

- Use existing and emerging technology, to investigate, research, and produce products and services, including new information, as required in the sector workplace environment.

5.0 Problem Solving and Critical Thinking

- Conduct short, as well as more sustained, research to create alternative solutions to answer a question or solve a problem unique to the sector using critical and creative thinking, logical reasoning, analysis, inquiry, and problem-solving techniques.

6.0 Health and Safety

- Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the sector workplace environment.

7.0 Responsibility and Flexibility

- Initiate, and participate in, a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the sector workplace environment and community settings.

8.0 Ethics and Legal Responsibilities

- Practice professional, ethical, and legal behavior, responding thoughtfully to diverse perspectives and resolving contradictions, when possible, consistent with applicable laws, regulations, and organizational norms.

9.0 Leadership and Teamwork

- Work with peers to promote divergent and creative perspectives, effective leadership, group dynamics, team and individual decision making, benefits of workforce diversity, and conflict resolution.

10.0 Technical Knowledge and Skills

- Apply essential technical knowledge and skills common to all pathways in the sector following procedures when carrying out experiments or performing technical tasks.

11.0 Demonstration and Application

- Demonstrate and apply the knowledge and skills contained in the Health Science and Medical Technology anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings and through the Cal-HOSA career technical student organization.

Pathway Standards

Manufacturing and Product Development - Product Innovation and Design Pathway

D1.0 Understand the basic product design and development process as it relates to the design of a product, line of products, system design, or services.

D2.0 Understand and apply research methodologies as a means to identify a need, problem, or opportunity for a new product, product line, system design, or service.

D3.0 Understand and apply various ideation techniques to develop ideas and concepts.

D4.0 Apply various two-dimensional (2-D) graphic and/or three-dimensional (3-D) modeling techniques to development concept.

D5.0 Develop the concept into a well-defined product for prototyping.

D10.0 Produce a presentation of the product, product line, system design, or service.

Engineering and Architecture – Engineering Technology Pathway

B3.0 Identify the fundamentals of the theory, measurement, control, and applications of electrical energy, including alternating and direct currents.

B5.0 Understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems.

B6.0 Employ the design process to solve analysis and design problems.

B8.0 Understand fundamental control system design and develop systems that complete preprogrammed tasks.

B10.0 Design and construct a culminating project effectively using engineering technology.

Common Core State Standards

ENGLISH LANGUAGE ARTS

Language Standards

LS 11-12.3: Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

LS 11-12.4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.

LS 11-12.6: Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the (career and college) readiness level, demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Reading Standards for Information Text

RLST 11-12.4: 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 11-12 texts and topics.

RSIT 11-12.7: Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

RLST 11-12.9: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Speaking and Listening Standards

SLS 11-12.2: Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions, and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SLS 11-12.1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners, building on others ideas and expressing their own clearly and persuasively.

SLS 11-12.1d: Respond thoughtfully to diverse perspectives, synthesize comments, claims and evidence made on all sides of an issue, resolve contradictions when possible, and determine what additional information or research is required to deepen the investigation or complete the work.

Writing Standards

WS 11-12.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WS 11-12.6: Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback including new arguments and information.

WS 11-12.7: 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.