



2023-2024
Mechatronics 1
 COURSE OUTLINE - UC

DESCRIPTION:

Mechatronics is the designing and manufacturing of products with electronics components and is used to develop major systems as well as day-to-day devices such as smartphones and household machines. This course focuses on the designing, manufacturing, and maintenance of products with electronic and mechanical components. Hence, students will obtain a fundamental understanding of lean manufacturing processes, structural engineering, mechanical systems, electricity, fluid power, CNC machine and Computer-Aided Design (CAD) to construct and design projects while applying print reading skills, properly using industry tools and practicing OSHA-10 safety skills throughout the course. By employing an interdisciplinary approach of reading, writing, problem solving, and hands-on projects students will acquire practical skills and industry knowledge for the advanced mechatronics course, entry-level employment in mechatronics/advanced manufacturing and preparation for SACA (Smart Automation Certification Alliance) C-101 Certified Industry 4.0 Associate I – Basic Operations silver certificate. Activities in this course include work-based learning that connect students to industry and the local community.

INFORMATION:

PRE-REQUISITE:	Algebra (Recommended)
LENGTH:	One Year
SECTOR:	Manufacturing and Product Development
PATHWAY:	Product Innovation and Design Pathway
ARTICULATED:	No
UC A-G APPROVAL:	Yes: College-Preparatory Elective (G) – Interdisciplinary 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, the ROP Student Rules of Conduct, and any operational guidelines.D. Review instructor/student expectations.E. Explain enrollment and attendance requirements and procedures.F. Review grading and student evaluation procedures.G. Discuss the community classroom 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 strategies for working effectively with each type.F. Practice business and social etiquette skills appropriate to the occupation.G. Discuss the role of business and personal ethics in the decision-making process.H. Evaluate various job-related scenarios and justify decisions based on ethics.I. Demonstrate flexibility and adaptability in working with others.J. 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 forms.
- C. Demonstrate interviewing techniques using appropriate tone and body language.
- D. Demonstrate appropriate dress and grooming standards in seeking employment and for the workplace.
- E. Identify strategies for employment retention.
- F. Analyze the impact of social networking on employability.
- G. Identify the need for continuing education, professional development, and professional growth in chosen field.
- H. Identify appropriate procedures for leaving a job.
- I. Identify sources of job information, including electronic sources.
- J. 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. Use a variety of means to positively impact the direction and actions of a team or organization.
- G. 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 / OSHA-10 Certification Competencies

- A. Demonstrate procedures to be followed in case of emergencies.
- B. Discuss 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. Demonstrate understanding of the procedure for reporting a work-related hazard or injury.
- F. Recognize the effects of substance abuse in the workplace.

6. History of Innovations in Manufacturing

- A. Compare and contrast the definition for mechatronics and manufacturing.
- B. Describe the impact of the industrial revolution on manufacturing.
- C. List key people in the past and present who have contributed to innovations in manufacturing and mechatronics.
- D. Describe the effect that automation and mechatronics have had on manufacturing.
- E. Identify various jobs and wages requiring mechatronics skills.
- F. List the various mechatronics certifications required for a career in advanced manufacturing.

G. Research job outlook and entry-level wages in mechatronics.

7. Modern Productivity Innovations

- A. List the steps of a typical manufacturing process.
- B. Describe Lean Manufacturing and discuss the benefits.
- C. Examine the effect of Industry 4.0 (the fourth industrial revolution) on the production floor.
- D. Describe the Industrial Internet of Things (IIoT) and its role in product development.
- E. Discuss forecasts for Industry 5.0.

8. Shop Safety / OSHA-10 Certification

- A. Locate OSHA and CAL-OSHA websites and identify resources that support worker safety.
- B. Differentiate Federal OSHA from CAL-OSHA.
- C. Summarize employee rights and employer duties under CAL-OSHA.
- D. Identify electrical safety and hazards when working with electronic equipment.
- E. 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.
- F. Describe the purpose, proper selection, and limitations of personal protection equipment (PPE) and demonstrate how to wear appropriate clothing, accessories, and hairstyles for shop/lab activities.
- G. Demonstrate how to correctly work and walk on surfaces to avoid, control, and protect against falls, slips and trips.
- H. List components of injury and illness prevention program.
- I. Demonstrate knowledge of material safety data sheets (MSDS).
- J. Follow general shop safety rules and procedures for handling tools/equipment.
- K. Describe proper ergonomics for materials handling, safe lift operation, and preventing workplace injury.
- L. Explain the importance of emergency preparedness and demonstrate procedures to be followed in emergencies.
- M. Describe common sources of fire and equipment necessary to prevent or extinguish fires, including how to use fire extinguishers.
- N. Describe and apply lockout/tagout procedures for accident and injury prevention. (OSHA).
- O. Pass safety tests.

9. Applied Math and Measurements

- A. Explain math concepts and formulas related to mechatronics and manufacturing.
- B. Use basic math involving addition, subtraction, multiplication, and division to solve equations consisting of decimals, fractions, percents, and integers.
- C. Demonstrate the proper selection, safe and accurate use, and maintenance of various measurement tools such as machinist's rule, calipers and micrometers.
- D. Identify various systems and methods of measurement used in manufacturing.
- E. Convert between S.I. metric and US Customary units of measurement.
- F. Demonstrate how to measure volume, surface area, and bounding box of geometric shapes.
- G. Analyze dimensional tolerances.
- H. Emphasize precision measurement for quality assurance purposes.
- I. Define basic terms and symbols used in print reading.

10. Hand and Machine Tools

- A. Demonstrate proper safety precautions when using various hand and machine tools.
- B. Demonstrate the proper selection, safe use, and maintenance of various hand and machine tools.
- C. List common hand tools used in the maintenance, installation, and repair of equipment.
- D. Identify various types and uses of fasteners, screws, and bolts in manufacturing.
- E. Demonstrate proper assembly of various manufacturing parts and components.
- F. Demonstrate various layout techniques.
- G. Recognize use and demonstrate safety precautions for power tools, cutting tools and other machine tools.

11. Structural Engineering

- A. Identify the types of structures.
- B. Explain the functions of structure types.
- C. Explain the concept of stability.
- D. Identify force vectors.

12. Mechanical Components and Principles

- A. Classify the three types of levers.
- B. Calculate the mechanical advantage of inclined planes, pulley systems, and gears.
- C. Create a drive system.
- D. Calculate RPM, shaft torque, rotary mechanical power, mechanical efficiency, and motor current.
- E. Install flexible jaw coupling between two different shafts.

- F. Demonstrate knowledge of the alignment procedure for various parts.
- G. Install a belt drive with multiple pulleys.
- H. Install a chain drive with multiple sprockets.
- I. Describe how to lubricate a system.

13. Computer Aided Design

- A. Create and interpret auxiliary views, orthographic projections, isometric drawings, oblique drawings and perspective drawings.
- B. Illustrate the types of breaks and symbols used in drawing sectional views.
- C. Add technical elements (e.g., parts lists, titles, finishes, tolerances, specifications, hidden surfaces) to drawings.
- D. Convert a 2D model into a 3D model.
- E. Translate a three-dimensional drawing or model into corresponding orthographic drawing views.
- F. Produce a reverse-engineered drawing from a solid object.
- G. Sketch a fully-dimensional, multi-view drawing.
- H. Evaluate a sketch and generate a model utilizing three-dimensional modeling software and techniques.
- I. Create a schematic of an electric control system utilizing three-dimensional modeling software and techniques.
- J. Apply manufacturing processes (e.g., casting, molding, forming, separating, conditioning, assembling, finishing, rapid prototyping).
- K. Compare and contrast conceptual, physical, and mathematical design models used to check proper design.
- L. Perform part manipulation during the creation of an assembly model.
- M. Analyze assembly constraints to successfully construct a multipart object.
- N. Describe assembling processes.
- O. Utilize part libraries effectively during the assembly modeling process.
- P. Employ subassemblies during the production of assemblies.
- Q. Verify drive constraints that simulate the motion of parts in assemblies.

14. Prototyping

- A. Examine the use of CAD, CAM, and CNC in prototyping.
- B. Recognize the advantages and disadvantages of Additive Manufacturing (AM).
- C. Identify various 3D printing processes.
- D. Identify advantages and disadvantages of various materials used in the 3D printing process.
- E. Explain the importance of finishing processes.
- F. Explain the importance of quality control and assurance.

15. Computer Numeric Control (CNC) Milling and Programming

- A. Describe configurations, parts and functions of common CNC machines in manufacturing.
- B. Select formulas which are used to determine milling machine settings.
- C. Define common G & M Codes for milling.
- D. Demonstrate proper use and safety precautions when operating a milling machine.
- E. Calculate settings needed for a milling machine.
- F. Interpret the actions that will be performed given a sample of machine code.
- G. Calculate spindle speed, feed rate, and cycle time optimization.
- H. Use canned cycle for boring, counter-boring, spot boring and pecking functions.
- I. Calculate cutter compensation.
- J. Scale larger objects down to smaller, identical objects without changing code.

16. Introduction to Electricity

- A. Demonstrate proper safety precautions when using electronic equipment and tools.
- B. Introduce electric currents, voltages, resistors, and batteries.
- C. Define electricity and electrical circuits.
- D. Articulate ohm's law and its applications.
- E. Calculate resistance, voltage, and current.
- F. Recognize parallel and series circuits.

17. Project Planning & Leadership

- A. Explain the importance and function of project management.
- B. Outline plan of a selected or given project.
- C. Identify group members and allocate tasks.
- D. Select appropriate materials, tools and timeframes for a given project.
- E. Calculate costs for a given project.
- F. Work with peers to promote divergent creative perspectives and leadership.
- G. Complete a finished product that meets industry standards.
- H. Assess and evaluate performance.
- I. Update portfolio for class projects.

18. Portfolio Design

- A. Create a professional digital portfolio reflecting employability skills in the relevant industry to include an "About Me" page.
- B. Collect original works (in photographs and videos) and documents that demonstrate technical skills and knowledge in the industry.
- C. Demonstrate knowledge of competencies by accompanying each selected document or work with a journal entry or summary.

- D. Write a brief resume and cover letter to be included in portfolio.
- E. Develop interviewing techniques using portfolio materials.
- F. Display portfolio materials for critique by a professional panel (industry partners and classmates).
- G. Gather feedback and update portfolio.

Key Assignments

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 2 3 5 18	2 3	2 3		LS 11-12.6 SLS 11-12.2
2. In groups, students will prepare and deliver a presentation based on researching major developments that led to the industrial revolution. Students will select a product and identify its evolution in production, the impact of subsequent production methods and technologies, the costs, customer demand, society changes, etc. and the various jobs that the production of this product created.	6	11 12	2	D 2.0	W 11-12.4 W 11-12.7
3. Working on an assigned local industry (or a facility in the local community toured by class in person or online), students will analyze problems with productivity, equipment, and overall efficiency issues, then write a proposal to implement new technology and change in processes. Students will create and share a presentation (max. of 10 slides) of the proposal. OR Students will use an open-source software* to retrieve production data to display and assess production statistics after connecting the Amatrol Skill Boss production station to a network switch on a PC. *For example, the squeak app.	7	5 10	2 5 9	D 1.0 D 3.0	SL 11-12.1
4. Students will perform a safety inspection and perform electrical pneumatic lockout/tagout procedures. Moreover, they will locate and interpret safety data sheets for the oil and grease supplied with the Skill Boss equipment. Upon inspecting chemicals/materials in the classroom, students will read labels and identify potential hazards, proper procedures for handling materials and required PPE. safety labeling on containers by examining the containers of materials in the classroom to determine their potential hazards. Amatrol Skill Boss 95-MSB2AB / Amatrol Hand Tools for Skill	1 3 8	2 6 8	2 6 7	D1	SLS 11-12.1 SLS 11-12.1b

Assignment	Competencies	Career Ready Practices	Anchor Standards	Pathway Standards	CCSS
Boss, Amatrol Mechanical Fabrication 950-MPF1.					
5. Students will practice measurement skills on projects throughout the year using Amatrol Measurement Tools 96-MES1 , the machinist's rule and converting between SI and US Customary units while applying various basic mathematical equations. Students will demonstrate the ability to measure accurately down to 1/64 of an inch or 0.5mm and the proper use of calipers and micrometers down to 0.001 mm or 0.0001 inch.	1 9	1 2 9	2 9 10	B2.0 B5.0 E2.9	LS 9-10, 11-12.6 SLS 11-12.1b WS 11-12.6
6. Match various types of fasteners on classroom equipment to correct tool. Students will demonstrate the proper method to tighten, loosen, remove, and install various tools using the Amatrol Hand tools for Skill Boss equipment. Amatrol Skill Boss 95-MSB2AB / Amatrol Hand Tools for Skill Boss, Amatrol Mechanical Fabrication 950-MPF1	5 10	4 5 10	1 4 10	D1.0	SEP 1-6
7. *Students will use a table saw, band saw, drill press, jigsaw, circular saw, reciprocating saw, lathe, and manual mill. Using basic layout techniques, students will manufacture a part that includes four different ways to create a hole and fasten parts together. Students will design and create their own pen. They will finish off with a household item replica project in which they have to re-create a common household item out of wood, plastic, or metal using any of the power tools above. *Not submitted for UC a-g	5 10	4 5 10	1 4 10	D1.0	SEP 1-6
8. Students will design a structure and evaluate its structural integrity. Students can design an earthquake shaker table or three bridges with 3 types of trusses accompanied by 3 body diagrams for each bridge with an explanation as to why each bridge is in equilibrium. Amatrol T9004	11	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

Assignment	Competencies	Career Ready Practices	Anchor Standards	Pathway Standards	CCSS
9. Students will identify mechanical components and practice real world motor drive servicing skills on Amatrol mechanical drives. 970-ME1 / 950-ME.	12	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
10. Students will create 3D models using industry standard. Students will open and change views of a solid model, identify features on a solid model, use the sketch entity tools to create a 2D solid model, and use the boss and extrude command to make the 2D solid model into a 3D model. Students will then make solid models of common household items and export those items into a CNC machine and manufacture the part using industry standard software. Students will submit G/M code for positioning and cutting commands.	1 9 13 -15	1 4 5 10	4 5 10	D1.0 D4.0 D5.0	CC 3 CC 6 SEP 1-6
11. Students will describe electrical circuits and use Ohm's Law. Students will use Amatrol's AC/DC Electrical Learning System T7017A to pass current through the circuit.	16	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
12. Final Project: Students will create an invention and write a report that focuses on the problems encountered how each team worked through each problem, produce 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 or participate in a competition.	1 2 4 17	2 9	2 9	D 10.0	SL 11-12.1 SL 11-12.4 SL 11-12.5 W 11-12.4
13. Students will work in teams for a "visual effects company" and build a catapult for an upcoming movie. The catapult must be steam powered, have a torque-speed converter, throw a tennis ball 65 feet, be operated at least 15 feet away by some sort of electric control, reloads automatically via a robot arm, controlled by a PLC device, and have at least 2 parts that are manufactured by a CNC machine.	2	5 10	2 5 9	D 1.0 D 3.0	SL 11-12.1

Assignment	Competencies	Career Ready Practices	Anchor Standards	Pathway Standards	CCSS
14. After successfully building a catapult, students will predict how far a golf ball will travel, how long, in seconds; it will travel in the air, and test their hypothesis by conducting three consecutive test launches. Students will use analytical, expository writing to document and describe their work on the project, recording this information into their engineering notebook.	1 6	2 5	2 9	D 7.0	SL 11-12.1 SL 11-12.4 W 11-12.4

Standards Assessed

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.