CareerClusters™ PATHWAYS TO COLLEGE & CAREER READINESS
Manufacturing

Learning that works for Colorado CTE®

Colorado CTE Course – Scope and Sequence

Course Name	**Robotics and Mechatronics Technology II**		**Course Details** **Course = 0.50 Carnegie Unit Credit**	**Credit = 1.0** **Prerequisite: Robotics and Mechatronics Technology I** **CTE Credential: CTE Manufacturing**	
Course Description	In this class students will research, design, and build projects based on the field of robotics automation. Students will learn about Pneumatics, Hydraulics, Electronics and Mechanical Design along with basics in Control and Programming by designing and building robotic systems.				
Note:	This is a suggested scope and sequence for the course content. The content will work with any textbook or instructional resource. If locally adapted, make sure all essential knowledge and skills are covered.				
SCED Identification #	21009	Schedule calculation based on 60 calendar days of a 90-day semester. Scope and sequence allows for additional time for guest speakers, student presentations, field trips, remediation, or other content topics.			
All courses taught in an approved CTE program must include Essential Skills embedded into the course content. The Essential Skills Framework for this course can be found at **https://www.cde.state.co.us/standardsandinstruction/essentialskills**					
Instructional Unit Topic	Suggested Length of Instruction	CTE or Academic Standard Alignment	Competency / Performance Indicator	Outcome / Measurement	CTSO Integration
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 Manufacturing sector workplace environment. Interpret policies, procedures, and regulations for the workplace environment, including	The student practices safe and proper work habits. The student is expected to: (A) master relevant safety tests; (B) comply with safety guidelines as described in various manuals, instructions, and regulations; (C) identify and classify hazardous materials and	Accurately read and interpret safety rules, including but not limited to the rules of handling high-pressure pneumatics and hydraulics. Analyze the implications of the various rules and employ them accordingly while working on mechatronic systems with control system components, explaining why certain rules apply. Identify and explain the intended use of safety equipment available in the	

		employer and employee responsibilities. Use health and safety practices for storing, cleaning, and maintaining tools, equipment, and supplies.	wastes according to Occupational Safety and Health Administration (OSHA) regulations; (D) dispose of hazardous materials and wastes appropriately; (E) comply with established guidelines for working in a lab environment; (F) handle and store tools and materials correctly; (G) employ established inventory control and organization procedures; and (H) describe the results of negligent or improper maintenance.	classroom. For example, demonstrate how to properly inspect, use, and maintain safe operating procedures with tools and equipment. Incorporate safety procedures and complete safety test with 100 percent accuracy.	
Fluid Power Systems			The student demonstrates an understanding of mechanical and fluid systems. The student is expected to:	Demonstrate understanding of the interrelationships and specific roles of (electro) pneumatic and hydraulic components and modules within a complex mechatronic system. For example, provide a written technical description of the expected changes in	

			(A) use mechanical devices; (B) use pneumatics devices; (C) use hydraulics devices; (D) define fluid power; and (E) compare and contrast pneumatic and hydraulic power systems.	one or more systems on other components and modules in the total mechatronic system. Identify the differences between hydraulic and pneumatic fluid power and justify decisions regarding when to use control systems based on one component as opposed to the other by crafting and defending an argument with specific claim(s), reasoning and supporting evidence. Create laboratory setups or simple control systems that apply hydraulic and pneumatic principles such as Boyle's Law and Pascal's Law. Apply these principles to solving problems and troubleshooting mechatronic systems, explaining the reasoning behind each step. Using real-world examples of hydraulic/pneumatic systems, and citing reputable print and visual sources of such systems, research the basic components and functions in a fluid power system. Create a visual aid to summarize and explain this information to	

				technicians or upper management. Measure and analyze basic physical properties of (electro) pneumatic and hydraulic components (such as cylinders, directional control valves, regulators, flow control valves, pumps, and motors) within a given system. Interpret resolved work orders by analyzing underlying issues and explaining the correct physical operation of the included components. Citing evidence from a technical description or actual observation of a mechatronic system, describe the flow of fluid energy in a given mechatronic system or subsystem. Create a graphic illustration to represent the transfer of energy from one component to others in the system.	
Computers and Control Systems		Understand how computers and control systems are used in mechatronic systems, modules, and subsystems. Understand fundamental control system design and develop systems that	The student develops the ability to use and maintain technological products, processes, and systems. The student is expected to:	Research the different roles of programmable logical controllers (PLCs) in complex mechatronic systems, modules, and subsystems, and be able to verbally describe their components and operation to others.	

		complete preprogrammed tasks. Program a computing device to control systems or process.	(A) demonstrate the use of computers to manipulate a robotic or automated system and associated subsystems; (B) troubleshoot and maintain systems and subsystems to ensure safe and proper function and precision operation; (C) implement feedback control loops used to provide information; and (D) implement different types of sensors used in robotic or automated systems and their operations.	Collaboratively create a technical document for a new technician that explains the basic components of a PLC, addressing how the role of a PLC varies in different systems (such as mechatronic systems, modules, and subsystems). Demonstrate understanding of the flow of information in a given mechatronic system or subsystem, focusing on the control function of PLCs in the system. Create both a schematic and explanatory narrative to describe the flow of information to/from an equipment operator. Given a control scenario, bound by several logical parameters, create Boolean logic equations to prescribe the use of logic gates in the implementation of the scenario. Show how they apply to the functioning of a real-world mechatronics system, explaining the reasoning involved. Demonstrate understanding of hexadecimal, decimal, octal, binary, 2s complement, and binary coded decimal (BCD) values as used in a	

				common PLC. Write an explanation or develop and deliver a brief presentation of how these codes are relevant to mechatronic systems. Convert wiring and ladder diagrams for simple logic chores into PLC programs that use common instructions such as digital, logical, compare, compute, move, file, sequencer, and program control instruction sets.	
Robotic Systems		Understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems. Identify the elements and processes necessary to develop a controlled system that performs a task. Demonstrate the use of sensors for data collection and process correction in controlled systems.	The student demonstrates an understanding of advanced mathematics and physics in robotic and automated systems. The student is expected to: (A) apply the concepts of acceleration and velocity as they relate to robotic and automated systems; (B) describe the term degrees of freedom and apply it to the design of joints used in robotic and automated systems;	Use mechanical tools, such as motors, gears, and gear trains in the construction of a robotic or automated system. Identify where forces are acting upon various points on the system and document with simple diagrams. Use the concepts of force, torque, and mechanical advantage to calculate the force acting upon the points in the system. Develop a system to demonstrate force, torque, work, and power acting upon or being done by a robotic or automated system. Justify the design by creating mathematical models that show the calculations.	

			(C) describe angular momentum and integrate it in the design of robotic joint motion, stability, and mobility; (D) use the impulse-momentum theory in the design of robotic and automated systems; (E) explain translational, rotational, and oscillatory motion in the design of robotic and automated systems; (F) apply the operation of direct current (DC) motors, including control, speed, and torque; (G) apply the operation of servo motors, including control, angle, and torque; (H) interpret sensor feedback and calculate threshold values; (I) apply measurement and geometry to calculate robot navigation;		

			(J) implement movement control using encoders; and (K) implement path planning using geometry and multiple sensor feedback.		
Technical Documents and Troubleshooting		Formulate and solve problems by using the appropriate units applied in mechanical, electrical, fluid, and thermal engineering systems.	The student develops a system using electrical controls and pneumatics or hydraulics devices. The student is expected to: (A) design a system that incorporates electrical controls and either a pneumatic or hydraulic device; (B) build a system that incorporates electrical controls and either a pneumatic or hydraulic device; and (C) test and troubleshoot the system that incorporates electrical controls and either a pneumatic or hydraulic device.	Use appropriate instruments to measure and record electrical, light, and audio outputs of a robotic system. Compare measured data to acceptable norms for the system. Document whether the system is performing within accepted parameters and cite evidence to support the claims. Perform maintenance or follow recommended procedures to correct malfunctions or underperformance within the system. Write a justification for any maintenance that is performed, citing data obtained from test results. Referencing technical documents (such as data sheets, circuit diagrams, displacement step diagrams, timing diagrams, function charts, operations manuals, and schematics) for	

				pneumatic and hydraulic components within a mechatronic system, assess the required maintenance for such systems, taking appropriate measurements where needed, and perform the necessary adjustments on these systems. Document and justify adjustments in an equipment log that can be referenced by technicians and engineers. Troubleshoot malfunctioning pneumatic and hydraulic systems: identify the source of the problem(s), plan a multistep procedure to correct the malfunction, implement the plan, and verify the corrective action. Using appropriate technical language and terminology, document the cause of the malfunction and justify the procedure used to correct it.	
Career Development		Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans.	Develop a career plan that reflects career interests, pathways, and postsecondary options. Student is expected to: (A) Research the scope of career opportunities available and the	Develop an informational annotated document, linked to bookmarked websites, illustrating the opportunities for students to investigate and experience engineering and technology while in school, focusing specifically on those programs offered by colleges	

			requirements for education, training, certification, and licensure; (B) Integrate changing employment trends, societal needs, and economic conditions into career planning; (C) Explore local employment requirements; and (D) Develop practical skills for obtaining employment.	and universities in Colorado and other states. For example, opportunities include job shadowing, internships, co-op programs, volunteer and community service, and part-time employment. Research and select a company or organization for a work-based learning project in an engineering or technology area of choice. Cite specific textual evidence from the organization's literature, as well as independent news articles to summarize: a. The mission and history of the organization b. Headquarters and organizational structure c. Products or services provided d. Credentials required for employment and how they are obtained and maintained e. Policies and procedures f. Reports, newsletters, and other documents published by the organization g. Website and contact information Search for the resumes of engineers and technologists retrieved from the websites of institutions, organizations, or	

				professional networks. Discuss what is typically included in the resumes of engineering and technology professionals, compare and contrast several examples, and create a personal resume modeled after elements identified in the search. Conduct a job search and simulate the experience by researching local employment options. In preparation for a future career in engineering or technology, complete an authentic job application form and compose a cover letter following guidelines specified in the vacancy announcement. Participate in a mock interview. Prior to the interview, prepare a paper that includes the following: tips on dress and grooming, most commonly asked interview questions, appropriate conduct during an interview, and recommended follow-up procedures. Upon completion of the interview, write a thank you letter to the interviewer in a written or email format.	
