Colorado CTE Course –

Course Name	**Engineering 3: Computer Integrated Manufacturing**	**Course Details** **Course = 0.50 Carnegie Unit Credit**	**1.0**
Course Description	*Computer Integrated Manufacturing is an advanced engineering course designed for students who want to deepen their skills in automation, robotics, product design, and manufacturing systems. This course prepares students for postsecondary pathways in engineering, advanced manufacturing, and technology-related fields. Through hands-on projects and industry-relevant software such as SolidWorks and Fusion 360, students gain experience with both additive and subtractive manufacturing, control systems, CNC machining, and system integration.* *Upon successful completion, students will be able to explain the role of engineers in modern manufacturing and automation systems, apply ethical and safety standards in engineering design and production, use CAD and CAM tools to develop and refine product prototypes, and program and operate robotic systems and CNC mills. They will also be able to analyze materials, costs, and system efficiency for production, collaborate in teams to design and execute a full-scale manufacturing process, and communicate and defend design solutions through technical documentation and presentations.*		
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 #		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

Unit Number, Title, & Description	Suggested Length	Academic Standard Alignment	CTE Competency / Performance Indicator	Outcome / Measurement	Linked Resources & CTSO
Unit 1 **Introduction to Manufacturing & the Engineering Design Cycle** Intro to modern manufacturing, ethical engineering, systems thinking, design cycle	3 weeks	**MA.HS.A-CED.A.1**, **MA.HS.F-BF.A.1a** (modeling and function building) **SC.HS.ETS1.A** (Defining problems), **SC.HS.PS1.A** (Structure of matter)	1) Identify and describe career options, working conditions, earnings, and educational requirements of various engineering disciplines 2) Recognize that engineers are guided by established condes emphasizing high ethical standards 3) Explore the differences, similarities, and interactions among engineers, scientists, and mathematicians 5) Discuss the history and importance of engineering innovation on the U.S> economy and quality of life 7) Know the definition of science and understand that it has limitations 8) Distinguish between scientific hypotheses and scientific theories	Students will create an engineering ethics case study and present a visual timeline of manufacturing innovation.	

Unit 2 **CAD for Additive Manufacturing** CAD basics, 3D printing safety, DFM concepts, intro to CSWA	2 weeks	**SC.HS.ETS1.B** (Developing and using models), **SC.HS.ESS3.C** (Human impacts) **MA.HS.G-GMD.A.3** (3D modeling with formulas), **MA.HS.G-MG.A.1** (applying geometry in context)	4) Describe how technology has evolved in the field of engineering and consider how it will continue to be a useful tool in solving engineering problems 13) Demonstrate safe practices during engineering laboratory and field activities 14) Demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of material. 30) Communicate visually by sketching and creating technical drawings using established engineering graphic tools, techniques, and standards	Students will design a functional part using CAD and produce a 3D-printed prototype.	
Unit 3 **Robotics & Sensors: Inputs & Outputs** Inputs/outputs, analog vs. digital signals, simple sensors and actuators	2 weeks	**MA.HS.F-IF.A.2**, **MA.HS.F-IF.C.7b** (piecewise and step functions) **SC.HS.PS3.D** (Energy in systems), **SC.HS.ETS1.C** (Optimizing design solutions)	19) Apply scientific processes and concepts relevant to engineering design problems 25) Identify the inputs, processes, outputs, control, and feedback associated with open and closed systems 26) Describe the difference between open-loop and closed-loop control systems 47) Work in teams and share responsibilities 48) Compare and contrast the roles of a team leader and other team responsibilities	Students will build and program a sensor-integrated robot to perform simple tasks.	

Unit 4 **Automation with VEX & Programming Logic** Loops, conditionals, automation control systems with VEX	**2 weeks**	**MA.HS.F-IF.B.4**, **MA.HS.A-REI.D.10** (analyzing function behavior, interpreting graphs) **SC.HS.PS3.C** (Energy and machines), **SC.HS.ETS1.C**	16) Communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials 19) Apply scientific processes and concepts relevant to engineering design problems 25) Identify the inputs, processes, outputs, control, and feedback associated with open and closed systems 32) Prepare written documents such as emails, design proposals, procedural directions, and technical reports using the formatting and terminology conventions of technical documentation 33) Organize information for visual display and analysis using appropriate formats for various audiences, including graphs and tables 43) Predict performance, failure modes, and reliability of a design solution	Students will complete challenges in VEX code using loops, conditionals, and sensor feedback.	
Unit 5 **Engineering for Manufacturability: Model Mania** Redesign flawed parts, apply DFM and tolerances, prepare CAM-ready models Also- *how to maintain equipment, troubleshoot problems, and perform basic repairs in a computer-integrated manufacturing environment.*	2 weeks	**MA.HS.F-BF.B.3**, **MA.HS.F-IF.C.7a** (transformation, interpretation) **SC.HS.ETS1.B**, **SC.HS.PS1.A**	20) Apply concepts, procedures, and functions of mathematics relevant to engineering design problems 30) Communicate visually by sketching and creating technical drawings using established engineering graphic tools, techniques, and standards 35) Defend a design solution in a presentation 40) Identify and create alternative solutions to a problem using a variety of techniques, such as brainstorming, reverse engineering, and researching engineered and natural solutions 49) Identify and manage the resources needed to complete a project 50) Use a budget to determine effective strategies to meet cost constraints	Students will reverse engineer a product, apply DFM concepts, and present design iterations.	

Unit 6 **Mass Property Analysis & Cost Considerations** Volume, density, cost, materials evaluation, packaging logic	2 weeks	**MA.HS.A-CED.A.4**, **MA.HS.A-REI.D.11**, **MA.HS.S-ID.B.6** (creating and solving equations, modeling data) **SC.HS.ETS1.C**, **SC.HS.PS1.A**, **SC.HS.ESS3.A**	10) Collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools. 11) Analyze, evaluate, make inferences, and predict trends from data 17) Draw inference based on data related to promotional materials for products and services 21) Select appropriate mathematical models to develop solutions to engineering design problems 27) Make measurements with accuracy and precision and specify tolerances 28) Use appropriate measurement systems, including customary and International System (SI) of units 29) Use conversations between measurement systems to solve real-world problems 40) Identify and create alternative solutions to a problem using a variety of techniques, such as brainstorming, reverse engineering, and researching engineered and natural solutions 51) Create a risk assessment for an engineering design project	Students will calculate mass properties, compare material costs, and document decisions.	
Unit 7 **CNC Machining & CAM** Intro to CNC, Fusion 360 CAM, mill operation, speeds/feeds	3 weeks	**MA.HS.F-IF.B.5**, **MA.HS.A-REI.A.1**, **MA.HS.S-ID.C.9** (rate of change, reasoning) **SC.HS.PS3.B** (Conservation of energy), **SC.HS.ETS2.A** (Technological impacts)	22) Integrate advanced mathematics and science skills as necessary to develop solutions to engineering design problems 23) Judge the reasonableness of mathematical models and solutions 24) Investigate and apply relevant chemical, mechanical, biological, electrical, and physical properties of materials to engineering design problems 31) Read and comprehend technical documents including specifications and procedures	Students will create a part file in Fusion 360, simulate toolpaths, and cut a part on the CNC mill.	
Unit 8 **Fluid Power & Mechanical Systems** Hydraulic and pneumatic systems, energy transfer, power calcs	2 weeks	**MA.HS.A-CED.A.1**, **MA.HS.A-CED.A.3**, **MA.HS.F-LE.A.1** (linear and exponential modeling) **SC.HS.PS3.A**, **SC.HS.PS3.D**, **SC.HS.ETS1.B**	6) Describe the importance of patents and the protection of intellectual property rights 15) Analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing 18) Evaluate the impact of scientific research on society and the environment 25) Identify the inputs, processes, outputs, control, and feedback associated with open and closed systems	Students will build a simple hydraulic lift and perform power calculations.	

			26) Describe the difference between open-loop and closed-loop control systems		
Unit 9 **Full System Simulation & Integration** Combine CAD/CAM, robotics, and control systems into simulated design	2 weeks	**MA.HS.A-REI.C.6**, **MA.HS.S-ID.B.6b**, **MA.HS.F-IF.C.7** **SC.HS.ETS1.C**, **SC.HS.PS3.A**, **SC.HS.ETS2.B**	19) Apply scientific processes and concepts relevant to engineering design problems 25) Identify the inputs, processes, outputs, control, and feedback associated with open and closed systems 32) Prepare written documents such as emails, design proposals, procedural directions, and technical reports using the formatting and terminology conventions of technical documentation 33) Organize information for visual display and analysis using appropriate formats for various audiences, including graphs and tables 43) Predict performance, failure modes, and reliability of a design solution	Students will prototype and test a multi-component automated system.	
Unit 10 **Manufacturing Systems Project** How It's Made- Team project: concept to product. Includes QA, project planning, evaluation Also- *quality control methodologies, inspection techniques, and the use of specialized tools for quality assurance in manufacturing.*	9 weeks	**MA.HS.S-ID.C.9**, **MA.HS.F-IF.C.9**, **MA.HS.A-REI.D.10** (comparing models, solving, interpreting) **SC.HS.ETS1.A–C** (Design), **SC.HS.PS3.B**, **SC.HS.PS4.C**, **SC.HS.ETS2.A**, **SC.HS.ETS2.B**	9) Plan and implement descriptive, comparative, and experimental investigations including asking questions, formulating testable hypotheses, and selecting equipment and technology. 36) Identify and define an engineering problem 37) Formulate goals, objectives, and requirements to solve an engineering problem 38) Determine the design parameters associated with an engineering problem such as materials, personnel, resources, funding, manufacturability, feasibility, and time 39) Establish and evaluate constraints pertaining to a problem, including health, safety, social, environmental, ethical, political, regulatory, and legal 41) Test and evaluate a proposed solution using methods, such as models, prototypes, mock-ups, simulations, critical design review, statistical analysis of experiments 42) Apply structured techniques to select and justify a preferred solution to a problem such as a decision tree, design matrix, or cost-benefit analysis 44) Prepare a project report that clearly documents the designs, decisions, and activities during each phase of the engineering design process 45) Participate in the design and implementation of a real-world or simulated engineering project using project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project	Students will prototype and test a multi-component automated system.	

			46) Develop a plan and project schedule for completion of a project 52) Analyze and critique the results of an engineering design project 53) Maintain an engineering notebook that chronicles work such as ideas, concepts, inventions, sketches, and experiments. 12) Communicate valid conclusions supported by data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and/or technology-based reports.		