COMPUTER INTEGRATED MANUFACTURING

Computer Integrated Manufacturing is a course that applies principles of rapid prototyping, robotics, and automation. Students will use computer controlled prototyping equipment, such as CNC mills, laser engravers, and 3D printers to solve problems by constructing actual models of their three-dimensional designs. Students will also be introduced to the fundamentals of robotics and how this equipment is used in an automated manufacturing environment. Students evaluate their design solutions using various techniques of analysis and make appropriate modifications before producing their prototypes.

- PLTW DOE Code: 4810
- NON-PLTW DOE Code: 5534
- Recommended Prerequisites: Introduction to Engineering Design and Principles of Engineering
- Credits: 2 semester course, 2 semesters required, 1 credit per semester, 2 credits maximum
- Counts as a Directed Elective or Elective for all diplomas
- If PLTW curriculum is used, PLTW training is required
- Qualifies as a quantitative reasoning course

Dual Credit

This course provides the opportunity for dual credit for students who meet postsecondary requirements for earning dual credit and successfully complete the dual credit requirements of this course. The Dual Credit crosswalk can be accessed here.

Application of Content and Multiple Hour Offerings

Intensive laboratory applications are a component of this course and may be either school based or work based or a combination of the two. Work-based learning experiences should be in a closely related industry setting. Instructors shall have a standards-based training plan for students participating in work-based learning experiences.

Implementation Guidance

Domain Zero (0) was created much like a process standard to be implemented throughout the length of the course. These standards should be taught in conjunction with Domains 1-7.

Career and Technical Student Organizations (CTSOs)

Career and Technical Student Organizations are considered a powerful instructional tool when integrated into Career and Technical Education programs. They enhance the knowledge and skills students learn in a course by allowing a student to participate in a unique program of career and leadership development. Students should be encouraged to participate in a Career and Technical Student Organization, such as the Technology Student Association (TSA).

Domain 0 – Project Management

Core Standard 1	**Students will exhibit appropriate safety practices while working with tools and equipment.**
ETE – 0.1.1	Demonstrate relevant safety practices when using tools and equipment as determined by task, materials, environment, and protective attire.
ETE – 0.1.2	Apply corrective action(s) to eliminate hazards.
	Understand the format and content of industry based Material Safety Data Sheets (MSDS).
Core Standard 2	**Students will investigate various careers within the fields of engineering and technology.**
ETE – 0.2.1	Identify engineering and technology occupations and the roles and responsibilities of each.
ETE – 0.2.2	Report job outlook, demand, and projected wages for engineering and technology careers.
ETE – 0.2.3	Explore job opportunities that are available in engineering and technology.
ETE – 0.2.4	Investigate post-secondary training opportunities and industry certifications that are available.
ETE – 0.2.5	Explore student professional organizations related to engineering and technology.
Core Standard 3	**Students will communicate the design process.**
ETE - 0.3.1	Explain the importance of documentation.
ETE - 0.3.2	Apply sketching and annotation skills to document work.
ETE - 0.3.3	Produce working drawings using appropriate drawing styles and techniques.
ETE - 0.3.4	Construct design models or finish models to display concepts of design or theory investigated.
ETE - 0.3.5	Document project components into an engineering notebook (digital or paper).
ETE - 0.3.6	Communicate technical knowledge in a variety of formats.
ETE – 0.3.7	Utilize presentation software to create a presentation that outlines team or individual priorities for design and share with peers.
ETE – 0.3.8	Document best work in a portfolio (digital or paper).
Core Standard 4	**Students will apply appropriate research techniques.**
ETE - 0.4.1	Formulate unbiased research questions to collect information/data.
ETE - 0.4.2	Apply appropriate investigative strategies.
ETE - 0.4.3	Evaluate sources appropriate for academic research.
ETE - 0.4.4	Select resources relevant to the identified problem.
ETE - 0.4.5	Synthesize information collected during the research process.
ETE - 0.4.6	Generate a list of sources used to gather information using APA or MLA format.

Content Standards

Domain – Drawing Development and Communication in a Manufacturing Environment

Core Standard 1 Students demonstrate use of computer-aided design (CAD) software to integrate effectively communication the design process, possible solution and execution of a project skills to solve a problem.

Standards

CIM – 1.1	Connect knowledge of diverse cultures, including global and historical perspectives, to the manufacturing environment.
CIM – 1.2	Recognize the impact of maufacturing processes on the environment.
CIM – 1.3	Demonstrate the ability to use CAD/CAM Systems.
CIM – 1.4	Utilize computer software for 2D profiling sketching functions.
CIM – 1.5	Define sketched objects with dimensions and geometric constraints.
CIM – 1.6	Identify the fundamentals of creating assembly models.
CIM – 1.7	Demonstrate the proper application of annotations and reference dimensions while conforming to established drafting standards.
CIM – 1.8	Inspect drawings for industry associated geometric, dimensioning, and tolerance (GD&T) standards.
CIM – 1.9	Update model and drawing views using revision specification sheets.
CIM – 1.10	Generate an assembly drawing, which includes views, balloons and bills of material.
CIM – 1.11	Recognize the wide array of industry-wide prototyping methods in use.
CIM – 1.12	Choose the appropriate manufacturing process for a prototype.

Domain – Robotics

Core Standard 2 Students evaluate the history and principles of robotics so they can determine a need for robots.

Standards

CIM-2.1	Discuss the chronological development of automation leading to robotics.
CIM-2.2	Identify the positive impact robots have on manufacturing.

Core Standard 3 Students establish knowledge of robotics so they can effectively select and manipulate the proper robot for the task.

Standards

CIM-3.1	Define a robot.
CIM-3.2	Describe the basic components of robot and their capabilities.
CIM-3.3	Classify different types of robots.
CIM-3.4	Compare and implement various robotics coordinate systems, paths and work envelopes and their uses.
CIM-3.5	Anayze and compare the various drive systems used in robotics.
CIM-3.6	Analyze degrees freedom and axis of motion in different types of robots.

CIM-3.8 Differenciate control techniques in real and in computer simulations.

CIM-3.9 Apply concepts of physics to an automated manufacturing environment.

CIM – 3.10 Describe the necessity for specialty tooling applications in robotics.

CIM – 3.11 Design, program, and troubleshoot robotics systems.

Domain – CNC

Core Standard 4 Students evaluate the history and principles of computer numeric control so they can determine the need for CNC equipment.

Standards

CIM-4.1 Explain the history of computer controlled machines charting the growth of numerical control (NC) and how it has been implemented into private industry.

CIM-4.2 Explain how the application of CNC machines has impacted manufacturing.

CIM-4.3 Explain the advantages and disadvantages of CNC machining.

Core Standard 5 Students evaluate proper methods for the setup and execution of CNC machining.

Standards

CIM-5.1 Examine different types of tool holding devices used in CNC machine tools.

CIM-5.2 Describe the difference between reference and position points.

CIM-5.3 Plot points using absolute, relative (incremental) and polar coordinates.

CIM-5.4 Identify the optimum location for the Point of Reference (PRZ).

CIM-5.5 Complete a preliminary planning sheet to identify necessary work holding devices, cutting tools, reference points, machining sequences and safe operation.

CIM-5.6 Compare and contrast shop floor programming with offline programming.

CIM-5.7 Demonstrate the ability to safely set up, maintain, and operate a CNC machine center using appropriate documentation and procedures.

CIM-5.8 Examine part geometry to select appropriate cutting tools and fixturing devices needed to create the part using a CNC machine.

CIM-5.9 Set up and edit the tool library of a CNC control program, providing offset values and tool geometry.

CIM-5.10 Calculate and verify appropriate spindle speeds and feed rates specific to each cutting tool utilized in an NC part program.

CIM-5.11 Verify NC part programs using simulation software before machining the part on a CNC device.

CIM-5.12 Follow a safety checklist before running an NC part program on a CNC machine.

CIM-5.13 Perform a dry run to verify the machine setup and program operation.

Core Standard 6 Students integrate computer aided manufacturing (CAM) systems to develop alpha numeric codes.

Standards

CIM-6.1	Demonstrate the ability to operate the user interface with various CAM systems.
CIM-6.2	Demonstrate the ability to import and export CAD files using a CAM package.
CIM-6.3	Set up a CAM package by editing the material and tool libraries, defining stock sizes, selecting the appropriate post processor, and defining the units of measure to be used.
CIM-6.4	Define and apply the fundamental and advanced milling and turning procedures used in manufacturing processes.

Domain – Automation

Core Standard 7 Students evaluate the benefits of automated manufacturing.

Standards

CIM-7.1	Describe how the individual components of a flexible manufacturing system (FMS) are interrelated.
CIM-7.2	Recognize the benefits and problems associated with CIM technology and how they impact the manufacturing process.
CIM-7.3	Justify the need for computer integrated manufacturing within an organization.
CIM-7.4	Identify the typical components and subsystems that make up an automated machining, assembly and process-type manufacturing operation.
CIM-7.5	Compare and contrast the benefits and drawbacks of the three categories of CIM systems.

Core Standard 8 Students apply concepts of machine communication to develop manufacturing processes.

Standards

CIM-8.1	Recognize the necessary safety precautions associated with a fully automated CIM system.
CIM-8.2	Develop machine order of operations.
CIM-8.3	Examine computer logic and scanning sequence in automated controls.
CIM-8.4	Describe the common parts of programmable logic controllers (PLC).
CIM-8.5	Design, program, and troubleshoot PLC systems.
CIM-8.6	Recognize the working relationship between the CNC mill and the robot.
CIM-8.7	Demonstrate how individual components work together to form a complete CIM system.