Course Description

Computer Integrated Manufacturing is an introduction to the fundamentals of computerized manufacturing technology. Students build on the solid modeling skills developed in the Introduction to Engineering Design course. Students use 3-D computer software to solve design problems. They assess their solutions through mass propriety analysis (the relationship of design, junction, and materials), modify their designs, and use prototyping equipment to produce 3-D models.

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<th>Core Code</th>
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<tr>
<td>Concurrent Enrollment Core Code</td>
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<tr>
<td>Units of Credit</td>
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<td>Intended Grade Level</td>
<td>10-12</td>
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<tr>
<td>Prerequisite</td>
<td>PLTW IDE, PLTW PoE</td>
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<td>Skill Certification Test Number</td>
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<td>License Type</td>
<td>Secondary Education 6-12</td>
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<td>Required Endorsement(s)</td>
<td>Technology &amp; Engineering, or Limited Engineering, or Engineering</td>
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STRAandal 1

Students will use 3D software for mass property analysis.

Standard 1

Apply necessary sketched features to generate a solid model.
- Demonstrate the ability to store, retrieve copy, and output drawing files depending upon system setup.
- Utilize 2D computer sketching functions.
- Incorporate various coordinate systems in the construction of 2D geometrical shapes.
- Calculate the X and Y coordinates given a radius and angle.
- Produce 2D sketches using available sketching features.
- Apply editing techniques to produce accurate sketches.
- Understand and apply sketch constraints.
- Analyze drawings with appropriate inquiry functions.
- Define sketched objects with dimensions and geometric constraints.
- Demonstrate the application and modifying of placed features.

Standard 2

Develop multi-view drawings such as top, front, right side, isometric, section, and auxiliary views from the solid model.
- Demonstrate the proper application of annotations and reference dimensions while conforming to established drafting standards.
- Update model and drawing views using revision specification sheets provided by the instructor.

Standard 3

Create assembly models through the integration of individual parts and sub-assemblies.
- Generate an assembly drawing, which include Views, Balloons, and Bill of Materials.

Standard 4

Prepare a prototype model from a drawing database.
- Identify the need for rapid-prototyping.
- Recognize the wide array of industry-wide prototyping methods in use.

STRAandal 2

Students will develop an understanding of the operating procedures and programming capabilities of machine tools.

Standard 1

Explain the history of Computer Controlled Machines charting the growth of NC and how it has been implemented into Private Industry.
- Explain how the application of CNC machines has impacted manufacturing.
- Explain the advantages and disadvantages of CNC Machining.
• Chart the evolution of machine tools, controllers, and software used in programmable machines.
• Explore career opportunities and educational requirements within the field of programmable machines.

Standard 2
Identify and explain the function of the major components of a CNC machine tool.
• Understand that CNC machine movements are identified by axes and that the axis system is a worldwide standard for machine movement.
• Define the three primary axes used in CNC machining and explore the remaining axes used in advanced machining.
• Identify the axis relative to various CNC machines.
• Contrast open and closed loop control systems.
• Identify the types of drive systems used in CNC machines.
• Identify Significant Points on geometric shapes (ex. Center point, end point).
• Identify the optimum location for the Program Reference Zero (PRZ) point.
• Use the CNC control program to indicate the machine position and then contrast that position to the relative position of the part origin (PRZ).
• Understand the difference between reference and position points.
• Be able to plot points using absolute, relative (incremental) and polar coordinates.
• Identify the three categories of machine movement: straight line, curved line, and non-regular shape.

Standard 3
Analyze part geometry to select appropriate cutting tools and fixturing devices needed to create the part using a CNC machine.
• Identify various types of tool changes used in CNC machine tools.
• Explain the importance of cutting tool materials and how they affect the speed and feed rates used by machine tools.
• Setup and edit the tool library of a CNC control program providing offset values and tool geometry.
• Calculate and verify appropriate spindle speeds and feed rates specific to each cutting tool utilized in an NC part program.
• Select appropriate cutting tools to efficiently, safely and accurately cut parts using a CNC machine.
• Complete a preliminary planning sheet to identify necessary work holding devices, cutting tools, reference points, machining sequences and safe operation.
• Examine different types of tool holding devices used in CNC machine tools.
• Apply various work holding devices commonly used for CNC machining.

Standard 4
Create a simple NC part program using a text editor and a CAM package.
• Write a basic NC part program using necessary G and M codes including remarks that describe the function of each code.
• Define the term “Alphanumeric Coding.”
• Define the term “G codes.”
• Define the term “M code.”
• Identify the three sections of a program: Initial Commands, Program Body, and Program End.
• Analyze, identify and correct errors found in NC part program files.
• Use simulation software to graphically verify NC program operation.
• Perform a “Dry Run” to verify the machine setup and program operation.

Standard 5
Employ a CAD/CAM/CNC software solution to create a part.
• Safely and accurately fixture a part in a CNC machine and set the program reference zero (PRZ).
• Verify NC part programs using a simulation software before machining the part on a CNC device.
• List and demonstrate all possible methods of disabling a CNC machine in the event of an emergency.
• Follow a safety checklist prior to running an NC part program on a CNC machine.
• Demonstrate the ability to safely setup, maintain and operate a CNC machine center using appropriate documentation and procedures.

Standard 6
Operate a CNC machine to cut a part to specifications.

STRAND 3
Students will convert computer-generated geometry into a program to direct the operation of CNC machine tools.

Standard 1
Read technical drawings identifying and understand the dimensional tolerances and limits.
• Measure using standard inch and metric systems.
• Convert measurements between metric and standard inch systems.

Standard 2
Make precision measurements to the degree of accuracy required by plan specification using appropriate instruments.
• Understand how comparison instruments can be used to check dimensions, compare shapes, indicate centers and check parallel surfaces.
• Be aware of advanced and automated measurement systems that are applied in industry. (e.g., Coordinate Measuring Systems, Digital Probes and Optical Scanners).
• Be aware of the importance of precision measurement in SPC and quality control.

Standard 3
Define the acronym CAM and explain what the purpose of a CAM package is.
• Demonstrate their ability to operate the user interface of a CAM package and access help using appropriate documentation and help screens.
• Perform basic file operations using a CAM package such as saving, opening, printing an editing part program files.
• Demonstrate an ability to import and export CAD files using a CAM package.
• Setup 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.
• Apply the fundamental and advanced milling and turning procedures used in CAM packages.
• Use a CAM package to generate and edit tool paths by applying appropriate machining processes to geometry from a CAD program.

STRAND 4
Students will program robots to handle materials in assembly-line operations.

Standard 1
Explore the chronological development of automation leading to robotics.
• Formulate a definition of a robot.
• Demonstrate the development of robotics from Science Fiction.
• Investigate career opportunities in the robotics career fields.
• Identify a minimum of four dangerous and repetitive jobs for which robots are used.
• Evaluate the positive impact robots have on manufacturing.
• Discuss the social implications of robots.

Standard 2
Identify and compare the four classifications of robots.
• Classify different types of robots.
• Investigate a classification of robot.

Standard 3
Design and build a working model of a robot.
• Identify and report specifications and work envelopes of robots.
• Identify and sketch the mechanical components to a robot.
• Recognize the need for end of arm tooling and how this tooling affects the robots operation.
• Understand the necessity for specialty tooling applications in robotics.
• Design and develop an end effector.
• Understand of the way end effectors are specific to a process.
• Prepare and document a presentation on end of arm tooling.

Standard 4
Understand the various drive systems used in robotics and analyze the advantages and disadvantages of each.
Standard 5
Understand the basic components of robot controllers.
- Demonstrate an understanding of control techniques and computer situations.
- Design and build a feed system with sensors.

Standard 6
Analyze and generate the solution to a robotic manufacturing problem.
- Program a robot to perform several tasks.
- Program a robot to solve a materials handling problem.

STRAND 5
Teams of students will design manufacturing work cells and tabletop factories to solve complex problems that arise in integrating multiple pieces of computer-controlled equipment.

Standard 1
Understand how the individual components of a flexible manufacturing system are interrelated.
- Recognize the benefits and problems associated with CIM technology and how they affect the manufacturing process.
- Identify some basic characteristics of a manufacturing operation that lend themselves to computer integrated manufacturing.
- Identify some of the typical components and sub systems that make up an automated machining, assembly and process-type manufacturing operation.
- Identify the three categories of CIM manufacturing systems.
- Compare and contrast the benefits and drawbacks of the three categories of CIM manufacturing systems.
- Recognize the working relationship between the CNC mill and the robot.

Standard 2
Explore the individual components used in selected CIM systems.
- Analyze and select components for a CIM system for a specific industrial application.
- Identify and study the relationship between a CNC milling machine interface and a jointed arm robot interface through a communication handshaking process.
- Understand the various applications of a Programmable Logic Controller as related to its use in a CIM system.
- Understand the difference between a PLC and a computer with interface.
- Recognize and understand the necessary safety precautions associated with a fully automated CIM system.
- Demonstrate how their individual components work together to form a complete CIM system.

Standard 3
Assemble and test their individual component designs by integrating them into a complete miniature FMS built from a robotic modeling kit.
• Identify the components of a FMS.
• Recognize and explain the significance of teamwork and communication when they combine the designs of the individual groups into a complete miniature FMS.