STRANDS AND STANDARDS
CAM AUTOMATED MANUFACTURING

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Course Description

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

Core Code	38.01.00.00.340
Concurrent Enrollment Core Code	None
Units of Credit	1.0
Intended Grade Level	11-12
Prerequisite	CAD Mechanical Design 2
Skill Certification Test Number	965
Test Weight	1.0
License Area of Concentration	Secondary Education
Required Endorsement(s)	Technology& Engineering, or
	Limited Engineering, or
	Engineering

STRAND 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.

STRAND 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.