The purpose of the Computer Integrated Manufacturing course is to expose students to the fundamentals of computerized manufacturing technology. The course is built around several key concepts:

**Computer Modeling** – using a three-dimensional, solid modeling software package with mass property analysis.

**CNC Equipment** – understanding the machine tools and its operating and programming aspects.

**CAM Software** – converting computer generated geometry into a program to drive CNC machine tools.

**Robotics** – using a robot for materials handling and assembly operations.

**Flexible Manufacturing Systems** – students working in teams to design manufacturing work cells and tabletop factory simulations.

The course will be taught using demonstration and discussion combined with individual and team-centered project based learning. In each of the learning sections students will be taught a different set of performance objectives.

**Unit and Section Outline**

**Unit 1 Computer Modeling**
- Section 1.1 Fundamentals
- Section 1.2 Object Construction
- Section 1.3 Parts Modeling
- Section 1.4 Creation of Working Drawings
- Section 1.5 Surface Modeling
- Section 1.6 Rapid Prototyping

**Unit 2 CNC Machining**
- Section 2.1 History of Programmable Machining
- Section 2.2 CNC Characteristics
- Section 2.3 CNC Programming
- Section 2.4 CNC Operations
- Section 2.5 CAM Software

**Unit 3 Robotics**
- Section 3.1 Introduction to Robotics
- Section 3.2 Robotics and Automated Systems
- Section 3.3 Robot Characteristics
- Section 3.4 Robot Controllers
- Section 3.5 Programming the Robot
- Section 3.6 End Effectors
- Section 3.7 Robot Applications

**Unit 4 Computer Integrated Manufacturing**
- Section 4.1 Rationales for CIM Manufacturing
- Section 4.2 Types of CIM Systems
- Section 4.3 Components of CIM Systems
- Section 4.4 CIM System Applications
Grading
The report card grade for CIM’s is based on the following criteria:
Content Area Assignments (labs, test, and drawings) .................................................. 49.0%
Effective Communicator Assignments (FMS Log & PPT) .............................................. 17.0%
Complex Thinker Activities (Projects) ........................................................................... 34.0%

Full year course ( Q1 + Q2 + Q3 + Q4 + Final Exam.) / 5  = Course grade
Semester course ( Q1 + Q1 + Q2 + Q2 + Final Exam.) / 5  = Course grade

Expectations
Students are expected to meet the following criteria in class:
• Good attendance
• Good classroom behavior and attitude
• Ability to meet deadlines
• Ability to show consideration for others
• Ability to solve problems
• Oral articulation of thoughts and ideas

Extra Help
If a student misses class, he/she is expected to make up the work missed. Further, if they are
having trouble with the course content, they are encouraged to seek extra help either during the
school day or after school.

Unit 1 Overview
COMPUTER MODELING

SECTION 1.1: Fundamentals
In this Section, the student will review the operations of Inventor by creating,
saving, and retrieving models. They will also use coordinate systems, pull down menus,
and layering, to organize and produce models. As the student moves through this
section, the many advantages of computer modeling will become immediately obvious

Section 1.2: Object Construction
In this Section, students will be able to produce 2D sketches using available sketching
features, apply editing techniques to produce accurate sketches, understand and apply
sketch constraints and analyze drawings with appropriate inquiry functions.

Section 1.3: Parts Modeling
In this Section, students will be able to define sketched objects with dimensions and
geometric constraints, apply necessary sketched features to generate a solid model and be
able to demonstrate the application and modifying of placed features.

Section 1.4: Creation of Drawing Views
In this Section, students will be able to develop multi-view drawings such as top, front,
right side, isometric, section and auxiliary views from the solid model. Students will be
able to demonstrate the proper application of annotations and reference dimensions while
conforming to established drafting standards.
Section 1.5: Assembly Modeling
In this Section, students will be able to create assembly models through the integration of individual parts and sub-assemblies. They will also be able to generate an assembly drawing, which include Views, Balloons, and Bill Of Materials (BOM).

Unit 2 Overview
PROGRAMMABLE MACHINES

Section 2.1: The History of Programmable Machining
Students will be able to explain the history of Computer Controlled Machines charting the growth of NC and how it has been implemented into Private Industry.
Students will be able to explain how the application of CNC machines has impacted manufacturing.
Students will be able to explain the advantages and disadvantages of CNC Machining.
Students will be able to chart the evolution of machine tools, controllers, and software used in programmable machines.

Section 2.2: CNC Characteristics
Students will identify the axis relative to various CNC machines.
Students will contrast open and closed loop control systems.
Students will identify the types of drive systems used in CNC machines.
Students will be able to use the CNC control program to indicate the machine position and then contrast that position to the relative position of the part origin (PRZ).
Students will be able to identify and explain the function of the major components of a CNC machine tool.

Section 2.3: CNC Programming
Students will understand the difference between reference and position points.
Students will understand that axes identify CNC machine movements.
Students will understand that the axis system is a worldwide standard for machine movement.
Students will be able to plot points using absolute, relative (incremental) and polar coordinates.
Students will be able to identify Significant Points on geometric shapes (ex. Centerpoint, end point).
Students will be able to identify the optimum location for the Program Reference Zero (PRZ) point.
Students will be able to identify the three categories of machine movement: straight line, curved line, and non-regular shape.
Students will be able to complete a preliminary planning sheet to identify necessary work holding devices, cutting tools, reference points, machining sequences and safe operation.
Students will be able to define the term “Alphanumeric Coding.”
Students will be able to define the term “G codes.”
Students will be able to define the term “M code.”
Students will be able to identify the three sections of a program; Initial Commands, Program Body, and Program End.
Students will be able to write a basic NC part program using necessary G and M codes including remarks that describe the function of each code.

Students will be able to explore the advantages and disadvantages of shop floor programming as well as off line programming.

Students will be able to create a simple NC part program using a text editor and a CAM package.

Students will be able to employ a CAD/CAM/CNC software solution to create a part.

Students will be able to analyze, identify and correct errors found in NC part program files.

Students will be able to use simulation software to graphically verify NC program operation.

Students will be able to perform a “Dry Run” to verify the machine setup and program operation.

Section 2.4: CNC Operations

Students will be able to demonstrate the ability to safely setup, maintain and operate a CNC machine center using appropriate documentation and procedures.

Students will be able to analyze part geometry to select appropriate cutting tools and fixturing devices needed to create the part using a CNC machine.

Students will be able to setup and edit the tool library of a CNC control program providing offset values and tool geometry.

Students will be able to calculate and verify appropriate spindle speeds and feed rates specific to each cutting tool utilized in an NC part program.

Students will be able to safely and accurately fixture a part in a CNC machine and set the program reference zero (PRZ).

Students will be able to verify NC part programs using simulation software before machining the part on a CNC device.

Students will be able to list and demonstrate all possible methods of disabling a CNC machine in the event of an emergency.

Students will follow a safety checklist prior to running an NC part program on a CNC machine.

Students will be able to perform a Dry Run to verify the machine setup and program operation.

Students will be able to operate a CNC machine to cut a part to specifications.

Section 2.5: Precision Measurement

Students will be able to measure using standard and metric systems.

Students will be able to convert measurements between metric and standard inch systems.

Students will be able to read technical drawings identifying and understand the dimensional tolerances and limits.

Students will be able to make precision measurements to the degree of accuracy required by plan specification using appropriate instruments.

Students will understand how comparison instruments can be used to check dimensions, compare shapes, indicate centers and check parallel surfaces.

Students will be aware of the importance of precision measurement in SPC and quality control.

Section 2.6: CAM Software

Students will be able to define the acronym CAM and explain what the purpose of a CAM package is.

Students will demonstrate their ability to operate the user interface of a CAM package and access help using appropriate documentation and help screens.
Students will be able to perform basic file operations using a CAM package such as saving, opening, printing and editing part program files.
Students will demonstrate an ability to import and export CAD files using a CAM package.
Students will 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.
Students will define and apply the fundamental and advanced milling procedure used in CAM packages.
Students will use a CAM package to generate and edit tool paths by applying appropriate machining processes to geometry imported from a CAD program.

Unit 3 Overview
INTRODUCTION TO ROBOTICS

Section 3.1: Introduction to Robotics

Students will explore the chronological development of automation leading to robotics. Students will demonstrate the development of robotics from Science Fiction. Students will identify a minimum of four dangerous and repetitive jobs that robots are used for.

Section 3.2: Robotics and Automated Systems

Students will formulate a definition of a robot. Students will be able to classify different types of Robots. Students will evaluate the positive impact robots have on manufacturing. Students will discuss the social implications of robots.

Section 3.3: Robot Characteristics

Students will identify and compare the four classifications of robots. Students will investigate a classification of robot. Students will identify and report specifications and work envelops of robots.

Section 3.4: Mechanical Components

Students will identify and sketch the mechanical components to a robot. Students will demonstrate their understanding of the way end effectors are specific to a process. Students will understand the various drive systems used in robotics and analyze the advantages and disadvantages of each.

Section 3.5: Control Systems

Students will understand the basic components of robot controllers. Students will demonstrate an understanding of control techniques and computer simulations.

Section 3.6: Programming Methods
Students will program a robot to perform several tasks. Students will program a robot to solve a materials handling problem. Students will recognize the need for end of arm tooling and how this tooling affects the robots operation.

Section 3.7: Industrial Robot Applications

Students will understand the necessity for specialty tooling applications in robotics. Students will analyze and generate the solution to a robotic manufacturing problem.

Unit 4 Overview
COMPUTER INTEGRATED MANUFACTURING

Section 4.1: Rationale for CIM Manufacturing

Students will understand how the individual components of a flexible manufacturing system are interrelated. Students will recognize the benefits and problems associated with CIM technology and how they affect the manufacturing process. Students will identify some basic characteristics of a manufacturing operation that lend themselves to computer integrated manufacturing.

Section 4.2: Types of CIM Systems

Students will identify the three categories of CIM manufacturing systems. Students will compare and contrast the benefits and drawbacks of the three categories of CIM manufacturing systems. Students will recognize the working relationship between the CNC mill and the robot. The students will be able to identify the components of a FMS.

Section 4.3: Components of CIM Systems

Students will identify and study the relationship between a CNC milling machine interface and a jointed arm robot interface through a communication handshaking process. Students will explore the individual components used in selected CIM systems. Students will analyze and select components for a CIM system for a specific industrial application. Students will understand the various applications of a Programmable Logic Controller as related to its use in a CIM system. Students will understand the difference between a PLC and a computer with interface.

Section 4.4: CIM System Applications

Students will recognize and understand the necessary safety precautions associated with a fully automated CIM system. Students will recognize and explain the significance of teamwork and communication when they combine the designs of the individual groups into a complete miniature FMS. Students will demonstrate how their individual components work together to form a
complete CIM system. Students will assemble and test their individual component designs by integrating them into a complete miniature FMS built from the Fischertechnik models.