



Dimond Engineering

COMPUTER INTEGRATED MANUFACTURING



Teacher: **Mr. Roach**

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Welcome to a course that covers how the modern world is made. You use technology everyday to make your life easier and more leisurely. Engineers invent, design, and prototype the technology that we use. Manufacturing processes are used to mass produce inexpensively and with high quality the products we need and want. This class will take you from design to product using design software, CNC machining, robotic automation and control to culminate in the modern computer integrated manufacturing process.

1. Computer Modeling (Inventor) 2. CNC Machining (EdgeCAM, proLight 1000 simulator)
 3. Robotics (Robotic Arm) 4. Computer Integrated Manufacturing (Handshaking, Automated work cell)

Materials required:

- ✓ D-Ring binder
- ✓ 3-Ring dividers
- ✓ Pen, pencil and eraser
- ✓ Flashdrive
- ✓ Calculator
- ✓ \$20 Lab Materials Fee (Wax, ButterBoard, Engineering Notebook)

Grading Policy

Notes / Classwork / Homework / Participation	20 %
Design Projects/Problems	40 %
Test / Quizzes	30 %
Citizenship	10 %
	100 %

A 89.5-100% **B** 79.5 -89.4% **C** 69.5-79.4% **D** 59.5-69.4% **F** below 59.5%

Design projects; These will be evaluated according to the project rubric that will be provided in the introduction of each project.

Tests & Quizzes; Tests will be given generally at the middle and/or the end of a Unit. Notes are not allowed. Quizzes will be given routinely. The use of notes is allowed during the quizzes unless otherwise indicated.

Notes; The student is required to keep a three ring binder with notes and projects of the class, and an engineering notebook according to the specifications of the Dimond Engineering Program.

Classwork; Most of the assignments including computer work will be done during class time. Be aware that time will be a restriction to complete your projects and assignments, use it wisely!!!

Homework; It will be assigned to reinforce the information taught during class. It will be kept in the three ring binder in a special section for homework.

Participation; All the projects of this class involve the collaboration of class members, it is important to work as a whole, be proactive and creative.

Grading Policy Citizenship Grade

A	B	C	D	F
On task at all time	On task most of the time	On task more of the time than off	Off task more often than on	Routinely off task
Prepared for class all of the time	Prepared for class most of the time	Prepared for class more often than not	Unprepared for class	Always unprepared for class
Works well with peers and teacher at all times	Works well with peers and teacher most of the time	Respectful of teacher and peers	Disrespectful at times	Disrespectful of peers and teacher more often than not
Exceptional behavior	No negative behaviors	Few disruptive behaviors	Frequent disruptive behaviors	Disrupts class frequently
Actively participates in class daily	Regularly participates in class	Participates more than not	Minimal participation in class	No participation in class
Enhances class performance by his/her presence	Sets a good example in class	Responds appropriately to critiques	Questions authority	Continually questions authority
<2 unexcused tardies or absences	2 unexcused tardies or absences	3 unexcused tardies or absences	4 unexcused tardies or absences	5 or more unexcused tardies or absences



Class Conduct (Expected Pattern of Behavior)

RESPECT	School, Teachers, Classmates, Equipment
RESPONSIBILITY	Assume actions / consequences
RELIABILITY	To do what is expected or required
COOPERATION	To work with others toward a common goal
HONESTY	To be sincere and to have integrity

Computer Integrated Manufacturing Curriculum Topical Outline

Unit 1: Computer Modeling

Lesson 1.1 Fundamentals

- 1.1.1. Drawing Editor
- 1.1.2. Menu Structures
- 1.1.3. Explain Desktop Startup Menu
- 1.1.4. Starting a New Drawing
- 1.1.5. Opening an Existing Drawing
- 1.1.6. Setting Limits/Units/Drawing Aids
- 1.1.7. Creating Drawing Layers
- 1.1.8. Coordinate Systems
 - 1.1.8.1. Absolute
 - 1.1.8.2. Polar
 - 1.1.8.3. Relative
- 1.1.9. Viewing Options
 - 1.1.9.1. Accelerator Keys
 - 1.1.9.1.1. Desktop View Toolbar
 - 1.1.9.1.2. View Pull Down Menu
- 1.1.10. Saving a Drawing

Lesson 1.2 Two-Dimensional Object Construction

- 1.2.1. Drawing Options
- 1.2.2. Editing Options
- 1.2.3. Geometric Constructions
- 1.2.4. Dimensioning
- 1.2.5. Analyzing

Lesson 1.3 Parts Modeling

- 1.3.1. Creating a Base Feature
 - 1.3.1.1. Sketching Options
 - 1.3.1.2. Profiling
 - 1.3.1.3. Constraining the Sketch
 - 1.3.1.4. Creating Work Features (Plane, Axis, Work Point)
 - 1.3.1.5. Creating a Solid
 - 1.3.1.6. Adding Dimensions to a Solid



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- 1.3.1.7. Browser Editing of the Model
- 1.3.2. Adding and Modifying Placed Features
 - 1.3.2.1. Fillet/Chamfer
 - 1.3.2.2. Holes
 - 1.3.2.3. Creating a Shell
 - 1.3.2.4. Copy/Array/Combine Options
- Lesson 1.4 Creation of Drawing Views
 - 1.4.1. Creating a Base View
 - 1.4.2. Creating Additional Views
 - 1.4.3. Adding/Editing Annotations and Reference Dimensions
 - 1.4.4. Modifying the Model and Drawing
- Lesson 1.5 Surface Modeling
 - 1.5.1. Surface Types
 - 1.5.1.1. Wireframe
 - 1.5.1.2. NURBS
 - 1.5.2. Surface Primitives
 - 1.5.2.1. Cones
 - 1.5.2.2. Cylinder
 - 1.5.2.3. Sphere
 - 1.5.2.4. Torus
 - 1.5.3. Motion-Based Surfaces
 - 1.5.3.1. Revolved
 - 1.5.3.2. Extruded
 - 1.5.3.3. Tubular
 - 1.5.3.4. Swept
 - 1.5.4. Skin Surfaces
 - 1.5.4.1. Rule
 - 1.5.4.2. Planar
 - 1.5.4.3. Lofted
 - 1.5.4.4. Lofted UV
 - 1.5.5. Derived Surfaces
 - 1.5.5.1. Blended
 - 1.5.5.2. Offset
 - 1.5.5.3. Fillet
 - 1.5.5.4. Corner Fillet
 - 1.5.6. Editing Surfaces
 - 1.5.6.1. Joining
 - 1.5.6.2. Trimming at Intersections
 - 1.5.6.3. Trimming by Projection
- Lesson 1.6 Assembly Modeling
 - 1.6.1. The Assembly Design Process
 - 1.6.1.1. Creating Components
 - 1.6.1.2. Instancing Components
 - 1.6.2. Assembling the Parts
 - 1.6.2.1. The Four Types of Constraints
 - 1.6.2.2. Understanding Positioning and Orientation Constraints
 - 1.6.2.3. Understanding Degrees of Freedom
 - 1.6.3. Getting Information from the Assembly
 - 1.6.3.1. Checking for Interference



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- 1.6.3.2. Retrieving Mass Property Information
- 1.6.4. Creating Assembly Scenes and Drawing Views
 - 1.6.4.1. Creating Exploded Assembly Scenes
 - 1.6.4.2. Creating the Assembly Drawing View
 - 1.6.4.3. Adding Annotations

Lesson 1.7 Prototyping

- 1.7.1. Introduction
- 1.7.2. Basic Concepts
- 1.7.3. Getting Started
- 1.7.4. Creating a Slice File
- 1.7.5. Preparing a Layout
- 1.7.6. Building a Prototype

Unit 2: CNC Machining

Lesson 2.1 History of Programmable Machining

- 2.1.1. The History of Computer Numerical Control
 - 2.1.1.1. Introduction
 - 2.1.1.2. Growth of CNC
 - 2.1.1.3. Private Industry and Numerical Control
- 2.1.2. Applications of CNC
 - 2.1.2.1. CNC in Industry
 - 2.1.2.2. Advantages of CNC
- 2.1.3. Evolution of Programmable Machining
 - 2.1.3.1. Machine Tool
 - 2.1.3.2. Controller
 - 2.1.3.3. Software
- 2.1.4. Careers in Programmable Machining
 - 2.1.4.1. Career Investigations
 - 2.1.4.2. Educational Requirements

Lesson 2.2 CNC Characteristics

- 2.2.1. Machine Components
 - 2.2.1.1. Axes Identification
 - 2.2.1.2. Feed Drive Systems
 - 2.2.1.3. Measuring Devices
 - 2.2.1.4. Spindle
 - 2.2.1.5. Work Piece Holding Tools and Fixtures
 - 2.2.1.6. Tool Changers
 - 2.2.1.7. Rotational Axes and Additional Feed Axes
- 2.2.2. Tooling
 - 2.2.2.1. Types of Cutting Tools
 - 2.2.2.2. Tool Holders
 - 2.2.2.3. Tool Geometry and Cutter Life

Lesson 2.3 CNC Programming

- 2.3.1. Points and Coordinates
 - 2.3.1.1. Reference Point Identification
 - 2.3.1.2. Coordinate Systems with Three Axes (X, Y, and Z)
 - 2.3.1.3. Polar Coordinates
 - 2.3.1.4. Absolute Cartesian Coordinates
 - 2.3.1.5. Incremental Cartesian Coordinates



- 2.3.1.6. Identifying Significant Points on the Part Geometry
- 2.3.1.7. Coordinating the Program Reference Zero (PRZ)
- 2.3.1.8. Types of Machine Movements
- 2.3.2. Preliminary Planning
 - 2.3.2.1. Steps in Planning
 - 2.3.2.1.1. How is the part going to be held?
 - 2.3.2.1.2. What are the steps to complete the process?
 - 2.3.2.1.4. Where will the PRZ be located?
 - 2.3.2.1.5. Can the part be measured?
 - 2.3.2.1.6. How will this program affect future operations?
- 2.3.3. NC Programming
 - 2.3.3.1. Alphanumeric Code Generation
 - 2.3.3.1.1. G Codes
 - 2.3.3.1.2. XYZ Coding
 - 2.3.3.1.3. M Codes
 - 2.3.3.1.4. Programming Functions
 - 2.3.3.2. Program Preparation Methods
 - 2.3.3.2.1. Off-Line Programming
 - 2.3.3.2.2. Shop-Floor Programming
 - 2.3.3.2.3. Manual and Computer Aided Programming
 - 2.3.3.3. Editing a Program
 - 2.3.3.3.1. Steps in Editing a Program
 - 2.3.3.3.2. Adding and Inserting Lines
 - 2.3.3.3.3. Deleting Lines
 - 2.3.3.3.4. Changing Lines
 - 2.3.3.4. Program Verification
 - 2.3.3.4.1. Graphic Verification
 - 2.3.3.4.2. Performing a Dry Run
 - 2.3.3.4.3. Error Messages

Lesson 2.4 CNC Operations

- 2.4.1. Safety in CNC Machine Operations
 - 2.4.1.1. Safety Skills
 - 2.4.1.2. Setup Documentation
 - 2.4.1.3. Program Testing and Verification
- 2.4.2. Machine Setup
 - 2.4.2.1. Selecting the Cutter Tooling
 - 2.4.2.2. Selecting the Tool Holders and Fixtures
 - 2.4.2.3. Setup Maintenance
 - 2.4.2.4. Loading and Unloading Material
 - 2.4.2.5. Setting the PRZ and Reference Points
 - 2.4.2.6. Entering Offset Data and Tool Geometry
- 2.4.3. Running a NC Program
 - 2.4.3.1. Safety Checklist
 - 2.4.3.2. Check Feed Rate and Spindle Speed
 - 2.4.3.3. Emergency Stops



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Lesson 2.5 Precision Measurements

- 2.5.1. Measurement Systems
 - 2.5.1.1. Standard
 - 2.5.1.1.1. Decimal
 - 2.5.1.1.2. Fractional
 - 2.5.1.2. Metric
 - 2.5.1.3. Conversion
- 2.5.2. Tolerances
 - 2.5.2.1. Tolerance Block
 - 2.5.2.2. Limits
- 2.5.3. Measurement Tool
 - 2.5.3.1. Steel Ruler – Combination Square Set
 - 2.5.3.2. Vernier Micrometer
 - 2.5.3.3. Vernier Caliper
 - 2.5.3.4. Transfer Tools
 - 2.5.3.4.1. Inside Calipers
 - 2.5.3.4.2. Outside Calipers
 - 2.5.3.5. Inside, Depth and Height Measurements
 - 2.5.3.5.1. Inside Micrometer
 - 2.5.3.5.2. Small Hole Gauges
 - 2.5.3.5.3. Telescoping Gauge
 - 2.5.3.5.4. Micrometer Depth Gauge
 - 2.5.3.5.5. Height Gauge
 - 2.5.3.6. Angular Measurement
 - 2.5.3.6.1. Vernier Protractor
 - 2.5.3.6.2. Sine Bar
 - 2.5.3.7. Comparison Tools
 - 2.5.3.7.1. Mechanical and Optical Comparator
 - 2.5.3.7.2. Dial Test Indicators
 - 2.5.3.8. Coordinate Measurement Systems
 - 2.5.3.9. Digital Probes
 - 2.5.3.10. Optical Scanners

Lesson 2.6 CAM Software

- 2.6.1. Introduction
 - 2.6.1.1. What is a CAM Package
 - 2.6.1.2. Graphical Interface and Selection Options
 - 2.6.1.3. Help Functions
- 2.6.2. Basic File Operation
 - 2.6.2.1. Opening a Program File
 - 2.6.2.2. Creating a New Program File
 - 2.6.2.3. Importing and Exporting DXF Files
 - 2.6.2.4. Saving and Printing a Program File
- 2.6.3. Program Setup
 - 2.6.3.1. Editing a Material Library
 - 2.6.3.2. Editing a Tool Library
 - 2.6.3.3. Defining Stock Size
 - 2.6.3.4. Selecting a Post Processor
 - 2.6.3.5. Defining Units of Measurement
- 2.6.4. Selecting and Editing Geometry, Tool Paths and Layering



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- 2.6.4.1. Selecting, Copying, Moving, and Deleting Geometry
- 2.6.4.2. Editing Tool Paths
- 2.6.4.3. Editing Layers
- 2.6.4.4. Wrapping and Unwrapping Geometry
- 2.6.5. Basic Machining
 - 2.6.5.1. Pocketing Operations
 - 2.6.5.2. Contouring Operations
 - 2.6.5.3. Facing Operations
 - 2.6.5.4. Engraving Operations
 - 2.6.5.5. Drilling Operations
- 2.6.6. Advanced Machining
 - 2.6.6.1. Swept Surface Operations
 - 2.6.6.2. Ruled Surface Operations
 - 2.6.6.3. Surface of Revolution Operations

Unit 3: Robotics

Lesson 3.1 Introduction to Robotics

- 3.1.1. Evolution of Robotics
 - 3.1.1.1. Science Fiction
 - 3.1.1.2. Chronology Development
 - 3.1.1.3. Future Uses
- 3.1.2. Jobs for Robots
 - 3.1.2.1. Hazardous
 - 3.1.2.2. Repetitive
- 3.1.3. Career Opportunities
 - 3.1.3.1. Operator
 - 3.1.3.2. Engineer
 - 3.1.3.3. Technical Support
 - 3.1.3.4. Sales

Lesson 3.2 Robotics and Automated Systems

- 3.2.1. Definition of a Robot
- 3.2.2. Types of Automation
 - 3.2.2.1. Hard Automation
 - 3.2.2.2. Flexible Automation
- 3.2.3. Rationale of Robotics
 - 3.2.3.1. Increase Productivity
 - 3.2.3.2. Improved Product Quality
 - 3.2.3.3. Reduce Scrap and Waste
 - 3.2.3.4. Improved Worker Safety
 - 3.2.3.5. Savings in Direct Labor Cost
- 3.2.4. Social Implications
 - 3.2.4.1. Human Displacement
 - 3.2.4.2. Changes in Job Skills

Lesson 3.3 Robot Characteristics

- 3.3.1. Classification of Robots
 - 3.3.1.1. Cartesian Coordinate System
 - 3.3.1.2. Cylindrical Configuration System
 - 3.3.1.3. Jointed Arm Configuration
 - 3.3.1.4. Polar Configuration



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- 3.3.2. Robot Specifications
 - 3.3.2.1. Axes of Motion
 - 3.3.2.1.1. Linear Side
 - 3.3.2.1.2. Base
 - 3.3.2.1.3. Shoulder
 - 3.3.2.1.4. Elbow
 - 3.3.2.1.5. Wrists
 - 3.3.2.2. Work Envelope
 - 3.3.2.2.1. Jointed Arm Configuration
 - 3.3.2.2.2. Polar Configuration
 - 3.3.2.2.3. Cylindrical Configuration
 - 3.3.2.2.4. Cartesian Configuration
 - 3.3.2.3. Speed
 - 3.3.2.4. Acceleration
 - 3.3.2.5. Payload
 - 3.3.2.6. Accuracy
 - 3.3.2.7. Resolution
 - 3.3.2.8. Repeatability
 - 3.3.2.9. Reliability

Lesson 3.4 Mechanical Components

- 3.4.1. Manipulator
 - 3.4.1.1. Base
 - 3.4.1.2. Arm Assembly
- 3.4.2. Actuators
 - 3.4.2.1. Pneumatic
 - 3.4.2.2. Hydraulic
 - 3.4.2.3. Electric
- 3.4.3. End of Arm Tooling
 - 3.4.3.1. Grippers
 - 3.4.3.1.1. Mechanical
 - 3.4.3.1.2. Vacuum Cups
 - 3.4.3.1.3. Magnetic
 - 3.4.3.1.4. Adhesive Applications
 - 3.4.3.2. Tools
 - 3.4.3.2.1. Nut and Screw Drivers
 - 3.4.3.2.2. Grinding/Abrasive
 - 3.4.3.2.3. Spray Painting
 - 3.4.3.2.4. Welding/Cutting

Lesson 3.5 Control Systems

- 3.5.1. Control Techniques
 - 3.5.1.1. Point to Point
 - 3.5.1.2. Continuous Path Control
 - 3.5.1.3. Artificial Intelligence
- 3.5.2. Controllers
 - 3.5.2.1. Hardware
 - 3.5.2.2. Software
 - 3.5.2.3. Data Storage
 - 3.5.2.4. Equipment Interfaces
- 3.5.3. Sensors



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- 3.5.3.1. Contact Sensors
 - 3.5.3.1.1. Limit Switches
 - 3.5.3.1.2. Tactile Sensors
- 3.5.3.2. Non-Contact Sensors
 - 3.5.3.2.1. Proximity
 - 3.5.3.2.2. Photo Optics
 - 3.5.3.2.3. Vision
 - 3.5.3.2.4. Miscellaneous (Temperature, Pressure, Force, etc.)

Lesson 3.6 Programming Methods

- 3.6.1. Guiding or Leading Through
- 3.6.2. Teach Pendant
- 3.6.3. Off-Line
 - 3.6.3.1. User Interface
 - 3.6.3.2. Menu Structure
 - 3.6.3.3. Editing Functions

Lesson 3.7 Industrial Robot Applications

- 3.7.1. Machining
 - 3.7.1.1. Drilling
 - 3.7.1.2. Grinding
 - 3.7.1.3. Sanding
 - 3.7.1.4. Routing
 - 3.7.1.5. Deburring
- 3.7.2. Finishing
 - 3.7.2.1. Spray Painting
 - 3.7.2.2. Gluing/Caulking
- 3.7.3. Welding/Cutting
 - 3.7.3.1. Arc and Gas Welding
 - 3.7.3.2. Laser/Plasma/Water Jet Cutting
- 3.7.4. Assembly
- 3.7.5. Inspection

Unit 4: Computer Integrated Manufacturing

Lesson 4.1 Rationale for CIM Manufacturing

- 4.1.1. Families of Parts
- 4.1.2. Random Introduction of Parts
- 4.1.3. Less Lead Time
- 4.1.4. Better Machine Utilization
- 4.1.5. Less Labor

Lesson 4.2 Types of CIM Systems

- 4.2.1. Special Systems (Least Flexibility)
- 4.2.2. Flexible Manufacturing Systems (Medium Flexibility)
- 4.2.3. Manufacturing Workcells (Most Flexibility)
- 4.2.4. Electronic Simplification Tools

Lesson 4.3 Components of CIM Systems

- 4.3.1. Computer Control
 - 4.3.1.1. Programmable Logic Controller (PLC)
 - 4.3.1.1.1. Definition of PLC
 - 4.3.1.1.2. Historical Development of PLC's



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- 4.3.1.1.3. Configuration of PLC
- 4.3.1.1.4. Operation of the PLC
- 4.3.1.1.5. Applications of PLC



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4.3.2. Machine Tool

4.3.2.1. CNC Machines

4.3.2.1.1. Lathes

4.3.2.1.2. Mills

4.3.2.1.3. EDM

4.3.2.1.4. Punch Press/Formatting

4.3.2.1.5. Laser and Water Jet Cutters

4.3.2.1.6. Grinding/Abrasive

4.3.3. Materials Handling

4.3.3.1. Machine Loading and Unloading

4.3.3.2. Conveyor Systems

4.3.3.3. Bins and Part Handling Systems

4.3.3.4. Inventory and Warehousing Systems

Lesson 4.4 CIM System Applications

4.4.1. Machining

4.4.2. Assembly

4.4.3. Process Operations