MT. DIABLO UNIFIED SCHOOL DISTRICT
COURSE OF STUDY

COURSE TITLE:	**Computer Integrated Manufacturing**
COURSE NUMBER:	**007719**
CBEDS NUMBER:	**5636**
DEPARTMENT:	**CTE**
LENGTH OF COURSE:	**Year Long**
CREDITS PER SEMESTER:	**5**
GRADE LEVEL(S):	**10, 11, 12**
REQUIRED OR ELECTIVE:	**Elective ("d)**

PREREQUISITES:

Required -	**None**
Recommended -	**Algebra 2, Principles of Eng. Or Intro to Eng. Design**

BOARD OF EDUCATION ADOPTION: (Date of Action Meeting)

COURSE DESCRIPTION:
Computer Integrated Manufacturing (CIM) is the use of computer techniques to integrate manufacturing activities. This course will examine the key elements of manufacturing and product development from the inception of the concept through design and all the way to final production. Students will interpret blueprints and select appropriate materials for final production. The use of computer software will help students understand the science behind pneumatics, sensors and materials testing that will set the foundation for the appropriate use of robotics, computer numerical control (CNC), computer-assisted design (CAD), and computer assisted manufacturing (CAM), and computer integrated manufacturing (CIM). Quality control and precision measurement will become critical components of the student's projects. Students will use state-of-the-art rapid prototyping machines, 3D Printer, and CNC Milling Router to produce a 3D prototype for projects. This course will enable students to experience the process of translating an idea into a finished product. Appropriate selection and identification of materials, recommend processes to treat and test materials will be necessary. Students must practice safe shop techniques and practices in operating shop equipment.

The course explores manufacturing history, individual processes, systems, and careers. In addition to technical concepts, the course incorporates finance, ethics, and engineering design. These reflect the integrated approach that leading manufacturers have adopted to improve safety, quality, and efficiency.

Utilizing the activity-project-problem-based (APPB) teaching and learning pedagogy, students will analyze, design, and build manufacturing systems. While implementing these designs, students will continually hone their interpersonal and collaborative skills, creative abilities, and understanding of the design process. Students apply knowledge gained throughout the course in a final open-ended problem to build a factory system.

COURSE PURPOSE:
Manufacturing transforms ideas into products. This course provides an opportunity for students to develop a better understanding of this innovative and exciting industry. Students learn about manufacturing processes, product design, robotics, and automation. Students develop their knowledge and skills of Computer Aided Design and Manufacturing to produce products using a Computer

Numerical Controlled (CNC) mill. Students apply the knowledge and skills gained in this course as they collaborate to design, build, and program factory system models.

COURSE OUTLINE:

Unit 1: Principles of Manufacturing

Students are introduced to the context that manufacturing is an evolution of processes and systems. Students are given the opportunity to explore a manufacturing topic in greater depth and share this knowledge with their peers while developing presentation skills. Students are introduced to a model for how manufacturing components interact to more efficiently manufacture products. Students will acquire efficient program creation techniques and apply them as they develop manufacturing system models and learn the use of input and output devices. The culmination of this unit will have the students integrate financial consideration into their manufacturing design and control system, and collaborate on a project to financially optimize a manufacturing process.

Unit 2: Manufacturing Processes

This unit will introduce students to manufacturing processes as discrete steps within a manufacturing system. Students analyze a product to consider design improvements, perform calculations to make manufacturing decisions, and recommend processes. Students explore manufacturing machines while learning to develop machine language called G&M code. Students create G&M code manually to understand how machine code controls a CNC device. Students then practice workflow as they design a part using CAD software, use powerful CAM software to create G&M code, and run that G&M code on a CNC mill to manufacture a part. Ultimately students operate a CNC mill and create a physical part with their G&M code.

Unit 3: Elements of Automation

The goal of this unit is to introduce students to robotic automation within a manufacturing system. Robots as a form of automation have improved manufacturing by performing tasks that may be too mundane, impossible, unsafe, or inefficient for humans to perform. Robot effectiveness is impacted by factors such as robot geometry, controlling program, and robot power sources. In this unit students create programs for a robot to move material similarly to pick and place operations typically used in an automated manufacturing setting. Students integrate a robot arm into a more complex environment through integration with other devices. used in an automated manufacturing setting. Students integrate a robot arm into a more complex environment through integration with other devices.

Unit 4: Integration of Manufacturing

The goal of this unit is to apply the course concepts to a capstone problem. This opportunity will allow students to develop teamwork and presentation skills. The unit also explores career opportunities available in the manufacturing industry. Students will connect the concepts learned in this course to manufacturing in a real-world setting though a visit to a manufacturing facility. The goal of this lesson is to provide students the opportunity to apply the knowledge and skills learned in this and previous engineering courses to a capstone problem. Student teams choose a product to manufacture. Students will break down the processes from simulated raw material to finished product. Students design, build, and program a flexible manufacturing system model with the same prototyping system used earlier in the course.

KEY ASSIGNMENTS:

Unit 1

1. Each student-pair will research a teacher-selected topic in manufacturing, develop a presentation, and present findings to the class.
2. Students will create a flowchart that portrays a manufacturing process.
3. Build a VEX robotic test bed and write programs to interface with input and output sensors and motors.
4. Using the VEX equipment, create a control system that replicates a factory cell.

Unit 2

1. Students will use knowledge of design to analyze the flaws in presented products.
2. Students will use solid modeling software to improve a flawed design.
3. Students will design and create a product using solid modeling software. Students will read and interpret G&M codes (machine code).
4. Students will transfer the drawings made in computer aided design program to a computer aided manufacturing program.
5. Students will create a designed part on a CNC machine as demonstrated by the instructor.

Unit 3

1. Students will research a topic in automation.
2. Students will create and program virtual robotic work cells with simulation software.
3. Students will solve problems involving fluid power. Construct a system to convert pneumatic power into mechanical power.
4. Students will learn the programming language needed to operate a Lynxmotion Robotic Arm and configure it to perform a set of tasks.

Unit 4

1. Students will compare and contrast and present the benefits and drawbacks of the three categories of CIM systems.
2. Students will present an exploration of a manufacturing or automation career of interest and determine the appropriateness and steps required to be a professional in that role.

Culminating Project

3. In four-person teams, design a manufacturing system that contains at least two automated components.
4. Complete the construction of each individual component of the miniature **F**actory **M**odel **S**ystem (FMS) and verify that each component works.
5. Assemble components into a working miniature FMS.
6. Start and maintain a journal that documents daily work.

INSTRUCTIONS METHODS and/or STRATEGIES:

1. Direct instruction (lecture, reading, labs, and investigations, engineering notebooks, guest speakers).
2. Laboratory investigations and project using educational courseware and computer technology.

3. Team teaching.
4. Use variety of instructional materials and resources including electronic media and reference materials.
5. Self-directed, cooperative, and collaborative learning to increase responsibility of students for their own learning.
6. Student presentations and exhibits– both team and individual.
7. Embedded assessments as a learning tool.
8. Differentiated instruction.

ASSESSMENTS INCLUDING METHODS and/or TOOLS

1. Problem based activities, graded by rubric
2. Key unit projects graded by rubric
3. Culminating comprehensive project
4. End of Course Exam

INSTRUCTIONAL MATERIALS:

In addition to the instructional material developed by Project Lead the Way through a national consortium of industry and education leaders, all students will demonstrate proficiency in the following:

- Microsoft Office (Excel, Word, PowerPoint)
- Autodesk Inventor solid modeling
- Autodesk HSM CAM software
- VEX robotic platform and RobotC programming software
- Intelitek CNC Motion

All course material, teacher presentations, and rubrics are provided to every student in electronic, and if needed, print format.

For CTE/Pathway/PLTW Distinction:

This course is designed with an industry partner and to be scheduled in a course sequence as follows.

Industry Partner: PLTW

Sequence of Courses:

Introduction to Engineering Design (year one)
Principles of Engineering (year two)
Computer Integrated Manufacturing (year three)

Optional:
Robotics Engineering (year four)

Committee Members:

1. **Tom Trowbridge**
2. **Joseph Alvarico**
3. **Marco Castro**
4. **Heather Fontanilla**
5. **Joe Alvarez**
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