Newport-Mesa Unified School District
Office of Secondary Curriculum and Instruction
High School Course of Study

Course Title	*Computer Integrated Manufacturing Re-Write*	**Course Code**	*KT366-367*

Transcript Title:	*Computer Integrated Manufacturing*	Grades Levels:	*11*	Board Adoption Date:	
Content Area:	***Engineering Design***	**GPA Scale:**	***4.0***	**Date Course Submitted:**	***3/16/18***
Credential Required:	*Yes--CTE*	Graduation Subject Areas:			
UC/CSU "A-G" Area Approvals:	*Yes*		School Site/person that wrote and submitted the course:	*Rich Mayfield*	
Recommend Skills:	*Strong Math Skills*				
Next course(s):	*Engineering Design Development*				

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DATE: **March 2018**

INDUSTRY SECTOR: **Engineering and Architecture**

PATHWAY: **Engineering Design (152)**

CBEDS TITLE: **Intermediate Engineering Design (Concentrator)**

CBEDS Code: **7731**

HOURS:

Total	Classroom	Laboratory/CC/CVE
180 hours	51 hours	129 hours

JOB TITLE	ONET CODES	JOB TITLE	ONET CODES
Manufacturing Engineer	17-2199.04	Manufacturing Engineering Technologist	17-3029.06

COURSE DESCRIPTION:

Computer Integrated Manufacturing is one of the specialization courses in the PLTW Engineering program. The course deepens the skills and knowledge of an engineering student within the context of efficiently creating the products all around us. Students build upon their Computer Aided Design (CAD) experience through the use of Computer Aided Manufacturing (CAM) software. CAM transforms a digital design into a program that a Computer Numerical Controlled (CNC) mill uses to transform a block of raw material into a product designed by a student. Students learn and apply concepts related to integrating robotic systems such as Automated Guided Vehicles (AGV) and robotic arms into manufacturing systems.

Throughout the course students learn about manufacturing processes and systems. This course culminates with a capstone project where students design, build, program, and present a manufacturing system model capable of creating a product.

PREREQUISITES:

High School Name:	**Site Prerequisite:**
Estancia	Introduction to Engineering Design
Estancia	Principles of Engineering

A – G APPROVAL: ☒ **Yes** ☐ **No** ☐ **Desired**

ARTICULATION:

High School Name:	**College Name:**	**College Course Title:**
N/A	N/A	N/A

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LEVEL: ☐ **Introductory** ☒ **Concentrator** ☐ **Capstone**

CERTIFICATION:

High School Name:	**Embedded/Leads to:**	**Description:**
N/A	N/A	N/A

METHOD OF STUDENT EVALUATION:

- ✓ Pre and Post test
- ✓ Student Projects
- ✓ Written work
- ✓ Observation record of student performance
- ✓ Completion of assignments and worksheets

METHOD OF INSTRUCTION:

- ✓ Lecture
- ✓ Group and individual applied projects
- ✓ Demonstration
- ✓ Field Trips
- ✓ Guest Speaker

RECOMMENDED TEXTS:

Curriculum resources provided on my.pltw.org

MODEL CTE PATHWAY:

Grade	**Fall Semester**	**Spring Semester**
9th	IED-1A	IED-1B
10th	POE-1A	POE-1B
11th	CIM-1A	CIM-1B
12th	EDD-1A	EDD-1B

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CALIFORNIA CAREER TECHNICAL EDUCATION MODEL CURRICULUM STANDARDS
California Department of Education CTE Standards website: http://www.cde.ca.gov/ci/ct/sf/ctemcstandards.asp

Advanced Manufacturing and Engineering
KNOWLEDGE AND PERFORMANCE ANCHOR STANDARDS

1.0 Academics
Analyze and apply appropriate academic standards required for successful industry sector pathway completion leading to postsecondary education and employment. Refer to the Engineering and Architecture academic alignment matrix for identification of standards.

2.0 Communications
Acquire and accurately use Engineering and Architecture sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats. (Direct alignment with LS 9-10, 11-12.6)
2.1 Recognize the elements of communication using a sender–receiver model.
2.2 Identify barriers to accurate and appropriate communication.
2.3 Interpret verbal and nonverbal communications and respond appropriately.
2.4 Demonstrate elements of written and electronic communication, such as accurate spelling, grammar, and format.
2.5 Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
2.6 Advocate and practice safe, legal, and responsible use of digital media information and communications technologies.

3.0 Career Planning and Management
Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans. (Direct alignment with SLS 11-12.2)
3.1 Identify personal interests, aptitudes, information, and skills necessary for informed career decision making.
3.2 Evaluate personal character traits, such as trust, respect, and responsibility, and understand the impact they can have on career success.
3.3 Explore how information and communication technologies are used in career planning and decision making.
3.4 Research the scope of career opportunities available and the requirements for education, training, certification, and licensure.
3.5 Integrate changing employment trends, societal needs, and economic conditions into career planning.
3.6 Recognize the role and function of professional organizations, industry associations, and organized labor in a productive society.
3.7 Recognize the importance of small business in the California and global economies.
3.8 Understand how digital media are used by potential employers and postsecondary agencies to evaluate candidates.
3.9 Develop a career plan that reflects career interests, pathways, and postsecondary options.

4.0 Technology
Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Engineering and Architecture sector workplace environment. (Direct alignment with WS 11-12.6)
4.1 Use electronic reference materials to gather information and produce products and services.
4.2 Employ Web-based communications responsibly and effectively to explore complex systems and issues.
4.3 Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources.

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4.4 Discern the quality and value of information collected using digital technologies, and recognize bias and intent of the associated sources.
4.5 Research past, present, and projected technological advances as they impact a particular pathway.
4.6 Assess the value of various information and communication technologies to interact with constituent populations as part of a search of the current literature or in relation to the information task.

5.0 Problem Solving and Critical Thinking
Conduct short, as well as more sustained, research projects to create alternative solutions to answer a question or solve a problem unique to the Engineering and Architecture sector using critical and creative thinking; logical reasoning, analysis, inquiry, and problem-solving techniques. (Direct alignment with WS 11-12.7)
5.1 Identify and ask significant questions that clarify various points of view to solve problems.
5.2 Solve predictable and unpredictable work-related problems using various types of reasoning (inductive, deductive) as appropriate.
5.3 Use systems thinking to analyze how various components interact with each other to produce outcomes in a complex work environment.
5.4 Interpret information and draw conclusions, based on the best analysis, to make informed decisions.

6.0 Health and Safety
Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Engineering and Architecture sector workplace environment. (Direct alignment with RSTS 9-10, 11-12.4)
6.1 Locate, and adhere to, Material Safety Data Sheet (MSDS) instructions.
6.2 Interpret policies, procedures, and regulations for the workplace environment, including employer and employee responsibilities.
6.3 Use health and safety practices for storing, cleaning, and maintaining tools, equipment, and supplies.
6.4 Practice personal safety when lifting, bending, or moving equipment and supplies.
6.5 Demonstrate how to prevent and respond to work-related accidents or injuries; this includes demonstrating an understanding of ergonomics.
6.6 Maintain a safe and healthful working environment.
6.7 Be informed of laws/acts pertaining to the Occupational Safety and Health Administration (OSHA).

7.0 Responsibility and Flexibility
Initiate, and participate in, a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the Engineering and Architecture sector workplace environment and community settings. (Direct alignment with SLS 9-10, 11-12.1)
7.1 Recognize how financial management impacts the economy, workforce, and community.
7.2 Explain the importance of accountability and responsibility in fulfilling personal, community, and workplace roles.
7.3 Understand the need to adapt to changing and varied roles and responsibilities.
7.4 Practice time management and efficiency to fulfill responsibilities.
7.5 Apply high-quality techniques to product or presentation design and development.
7.6 Demonstrate knowledge and practice of responsible financial management.
7.7 Demonstrate the qualities and behaviors that constitute a positive and professional work demeanor, including appropriate attire for the profession.
7.8 Explore issues of global significance and document the impact on the Engineering and Architecture sector.

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8.0 Ethics and Legal Responsibilities
Practice professional, ethical, and legal behavior, responding thoughtfully to diverse perspectives and resolving contradictions when possible, consistent with applicable laws, regulations, and organizational norms. (Direct alignment with SLS 11-12.1d)
8.1 Access, analyze, and implement quality assurance standards of practice.
8.2 Identify local, district, state, and federal regulatory agencies, entities, laws, and regulations related to the Engineering and Architecture industry sector.
8.3 Demonstrate ethical and legal practices consistent with Engineering and Architecture sector workplace standards.
8.4 Explain the importance of personal integrity, confidentiality, and ethical behavior in the workplace.
8.5 Analyze organizational culture and practices within the workplace environment.
8.6 Adhere to copyright and intellectual property laws and regulations, and use and appropriately cite proprietary information.
8.7 Conform to rules and regulations regarding sharing of confidential information, as determined by Engineering and Architecture sector laws and practices.

9.0 Leadership and Teamwork
Work with peers to promote divergent and creative perspectives, effective leadership, group dynamics, team and individual decision making, benefits of workforce diversity, and conflict resolution as practiced in the SkillsUSA career technical student organization. (Direct alignment with SLS 11-12.1b)
9.1 Define leadership and identify the responsibilities, competencies, and behaviors of successful leaders.
9.2 Identify the characteristics of successful teams, including leadership, cooperation, collaboration, and effective decision-making skills, as applied in groups, teams, and career technical student organization activities.
9.3 Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace setting.
9.4 Explain how professional associations and organizations and associated leadership development and competitive career development activities enhance academic preparation, promote career choices, and contribute to employment opportunities.
9.5 Understand that the modern world is an international community and requires an expanded global view.
9.6 Respect individual and cultural differences and recognize the importance of diversity in the workplace.
9.7 Participate in interactive teamwork to solve real Engineering and Architecture sector issues and problems.

10.0 Technical Knowledge and Skills
Apply essential technical knowledge and skills common to all pathways in the Engineering and Architecture sector, following procedures when carrying out experiments or performing technical tasks. (Direct alignment with WS 11 -12.6)
10.1 Interpret and explain terminology and practices specific to the Engineering and Architecture sector.
10.2 Comply with the rules, regulations, and expectations of all aspects of the Engineering and Architecture sector. 10.3 Construct projects and products specific to the Engineering and Architecture sector requirements and expectations.
10.4 Collaborate with industry experts for specific technical knowledge and skills.

11.0 Demonstration and Application
Demonstrate and apply the knowledge and skills contained in the Engineering and Architecture anchor standards, pathway standards, and performance indicators in classroom, laboratory and workplace settings, and through the SkillsUSA career technical student organization.
11.1 Utilize work-based/workplace learning experiences to demonstrate and expand upon knowledge and skills

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gained during classroom instruction and laboratory practices specific to the Engineering and Architecture sector program of study.
11.2 Demonstrate proficiency in a career technical pathway that leads to certification, licensure, and/or continued learning at the postsecondary level.
11.3 Demonstrate entrepreneurship skills and knowledge of self-employment options and innovative ventures.
11.4 Employ entrepreneurial practices and behaviors appropriate to Engineering and Architecture sector opportunities.
11.5 Create a portfolio, or similar collection of work, that offers evidence through assessment and evaluation of skills and knowledge competency as contained in the anchor standards, pathway standards, and performance indicators.

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CR = Classroom LAB/CC = Laboratory/Shop/Community Classroom

1	**PRINCIPLES OF MANUFACTURING**	**CR**	**LAB/CC**	**STANDARDS**
	Manufacturing has a long history of innovation and continuous improvement. While improvement once focused on refining individual manufacturing processes, more recently manufacturing has been considered a system. Sustainable manufacturing organizations focus on safety while improving material, financial, and time efficiency. The integration of hardware and software solutions is transforming worldwide manufacturing into predominantly computer integrated manufacturing. In this unit students will explore the history of manufacturing and understand how manufacturing components are interconnected within a system. Students will learn to use input and output devices as a foundation to model manufacturing processes. The design of a model is refined through the introduction of financial consideration. ● **Lesson 1.1 History of Manufacturing** ○ The goal of this lesson is to provide context for manufacturing as 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. ● **Lesson 1.2 Control Systems** ○ The goal of this lesson is for students to learn the use of input and output devices. Students will acquire efficient program creation techniques and apply them as they develop manufacturing system models. ● **Lesson 1.3 Cost of Manufacturing** ○ The goal of this lesson is to integrate financial consideration into manufacturing design. Students collaborate on a project as they financially optimize a manufacturing system.	10	23	**Academic:** AS.R.1,2,7,10 AS.W.2-4,8,9 AS.SL.1,2,4-6 AS.L.1-6 RSIT 11-12.2 RHSS 11-12.2,7,10 RLST 11-12.2,4,7,10 AD 12.3 PE 12.1,2 US 11.5,6,8,11 WH 10.3,9,11 CSR 1,4 CC 3,6,7 G-MG 3 SEP 4-6,8 LS 11-12.1-2 WS 11-12.2,4-8 WHSST 11-12.2,6 SEP 6-8 ETS 2.A,B **CTE Anchor:** 1.0 2.0 4.0 5.0 6.0 9.0 10.0 11.0 **CTE Pathway:** C1.0 C2.0 C9.0 C11.0

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2	**MANUFACTURING PROCESSES**	**CR**	**LAB/CC**	**STANDARDS**
	The goal of unit 2 is to 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. ● **Lesson 2.1 Designing for Manufacturability** ○ The goal of this lesson is consider how an effective product could be efficiently manufactured. In this lesson students analyze bad designs and discuss ways in which these could be improved. Students develop and apply formulas related to manufacturing scenarios while considering safety and ethics. ● **Lesson 2.2 How We Make Things** ○ The goal of this lesson is to build a foundation of manufacturing process knowledge. Students are shown processes and the associated machines as these are applied to product manufacturing. Students apply this knowledge as they analyze products and recommend effective manufacturing processes. ● **Lesson 2.3 Product Development** ○ The goal of this lesson is for students to execute a workflow from product concept through product creation using a CNC mill. A CNC mill uses a machine language called G&M code to move a cutting tool to remove raw material, resulting in a final product. Students create G&M code manually to understand how machine code controls a CNC device. As students prepare to operate a CNC mill, they learn how to calculate appropriate mill settings to produce products safely and efficiently. Students then practice	15	50	**Academic:** AS.R.1,2,7,10 AS.W.2-4,8,9 AS.L.1-6 AS.SL.2,4-6 N.Q.1,3 N.VM.4 A.SSE.1.a A.CED.4 A.REI.1,3,10 G.GMD.4 G.MG.1-3 F.LE.5 G.SRT.8 RSIT 11-12.2 RHSS 11-12.2,7,10 RLST 11-12.2,4,7,10 AD 12.3 PE 12.1,2 US 11.5,6,8,11 WH 10.3,9,11 CSR 1,4 CC 3,6,7 G-MG 3 SEP 4-6,8 LS 11-12.1-2 WS 11-12.2,4-8 WHSST 11-12.2,6 SEP 6-8 ETS 2.A,B **CTE Anchor:** 1.0 2.0 4.0 5.0 6.0 9.0 10.0 11.0 **CTE Pathway:** C1.0 C2.0

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	workflow as they design a part with CAD software and convert the CAD model into G&M code using powerful CAM software. Ultimately students program and operate a CNC mill to create a physical part with their G&M code.			C9.0 C11.0
3	**ELEMENTS OF AUTOMATION**	**CR**	**LAB/CC**	**STANDARDS**
	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 Computer Integrated Manufacturing | Course Outline 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. ● **Lesson 3.1 Introduction to Robotic Automation** ○ The goal of this lesson is to develop a deeper understanding of the application of robotic automation within manufacturing. In this lesson students are provided a historical frame of reference for robotic automation development. Students create automated sequences that instruct a robot to complete a task in a simulated environment. ● **Lesson 3.2 Introduction to Automation Power** ○ The goal of this lesson is for students to apply power concepts related to robotic automation. Students apply power formulas to solve theoretical engineering problems. Students design, build, and develop a program to model the use of fluid power to complete a task. ● **Lesson 3.3 Robotic Programming and Usage** ○ The goal of this lesson is to apply concepts learned in the previous lessons to a physical robot. Students create programs to control a	12	26	**Academic:** N.Q.1-3,5,6 A.CED.4 A.REI.3 F.TF.7 G.SRT.8 AS.L.1,2,5,6 RSIT 11-12.2 RHSS 11-12.2,7,10 RLST 11-12.2,4,7,10 AD 12.3 PE 12.1,2 US 11.5,6,8,11 WH 10.3,9,11 CSR 1,4 CC 3,6,7 G-MG 3 SEP 4-6,8 LS 11-12.1-2 WS 11-12.2,4-8 WHSST 11-12.2,6 SEP 6-8 ETS 2.A,B **CTE Anchor:** 1.0 2.0 4.0 5.0 6.0 9.0 10.0 11.0 **CTE Pathway:** C1.0 C2.0 C9.0

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	robot arm. Ultimately students will integrate the robot into complex systems through communication with other control systems.			C11.0
4	**INTEGRATION OF MANUFACTURING**	**CR**	**LAB/CC**	**STANDARDS**
	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. ● **Lesson 4.1 CIM Systems** ○ Students will connect the concepts learned in this course to manufacturing in a real-world setting though a visit to a manufacturing facility. This lesson will also introduce manufacturing career opportunities. ● **Lesson 4.2 Integration of Manufacturing** ○ 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.	12	26	**Academic:** AS.R.10 AS.W.2-4,9 AS.SL.1,4-6 AS.L.1-6 RSIT 11-12.2 RHSS 11-12.2,7,10 RLST 11-12.2,4,7,10 AD 12.3 PE 12.1,2 US 11.5,6,8,11 WH 10.3,9,11 CSR 1,4 CC 3,6,7 G-MG 3 SEP 4-6,8 LS 11-12.1-2 WS 11-12.2,4-8 WHSST 11-12.2,6 SEP 6-8 ETS 2.A,B **CTE Anchor:** 1.0 2.0 4.0 5.0 6.0 9.0 10.0 11.0 **CTE Pathway:** C1.0 C2.0 C9.0 C11.0

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	EMPLOYMENT PORTFOLIO	**CR**	**LAB/CC**	**STANDARDS**
	Students will prepare a professional portfolio. 1. Portfolio showcases best professional level work 2. Portfolio is organized 3. Job application 4. Resume 5. References		4	**Academic:** AS.W.2.4,6,9,10 AS.SL.1,2,5 AS.L.1,2.6 LS 11-12.1-2 RLST 11-12.2,4,7 WS 11-12.2,4-8 WHSST 11-12.2,6 SEP 7-8 ETS 2.A,B **CTE Anchor:** 3.0 **CTE Pathway:** C11.0