



El Camino College
 COURSE OUTLINE OF RECORD – Official

Course Acronym:	MTT
Course Number:	10K
Descriptive Title:	3D Numerical Control Graphics Programming
Division:	Industry and Technology
Department:	Machine Tool Technology
Course Disciplines:	Machine Tool Technology
Catalog Description:	This course covers Computer Aided Manufacturing (CAM), emphasizing interactive graphics programming for Computer Numerical Control (CNC) machines. Students will utilize various techniques for creating geometry on multiple work planes, three-dimensional (3D) surface toolpath creation and manipulation, implementing 4th axis machining, generating surface to surface intersections, creating blends between surfaces, creating roughing operations for 3D and Computer Aided Design (CAD) data conversion for the purpose of 3D machining.
Prerequisite:	Machine Tool Technology 10J with a minimum grade of C
Co-requisite:	
Recommended Preparation:	
Enrollment Limitation:	
Hours Lecture (per week):	2
Hours Laboratory (per week):	3
Outside Study Hours:	4
Total Course Hours:	90
Course Units:	3
Grading Method:	Letter Grade only
Credit Status:	Credit, degree applicable
Transfer CSU:	yes
Effective Date:	fall 1995
Transfer UC:	No
Effective Date:	
General Education:	ECC
Term:	
Other:	
CSU GE:	
Term:	

Other:	
IGETC:	
Term:	
Other:	
<p>Student Learning Outcomes:</p>	<p>SLO #1 Creating a 3D Solid Model</p> <p>Student will correctly create a 3D solid model in CAD software and practice roughing the 3D surface using CAM software.</p> <p>SLO #2 4th and 5th Axis Positioning</p> <p>The student will be able to describe and demonstrate appropriate 3D editing operations, and use 4th and 5th axis positioning and simultaneous rotary axis machining operations on 3D process models.</p> <p>SLO #3 Surfacing</p> <p>The student will be able to construct appropriate profile geometry on which to base 3D surfaces, recognize what surface type would be required, and practice roughing of 3D surfaces.</p>
<p>Course Objectives:</p>	<ol style="list-style-type: none"> 1. Differentiate between two-dimensional (2D) and 3D functions. 2. Construct appropriate profile geometry on which to base 3D surfaces and to recognize what surface type would be required. 3. Create 3D surfaces as toolpath or non-toolpath geometry. 4. Describe and demonstrate appropriate 3D editing operations. 5. Use 4th axis positioning and simultaneous rotary axis machining operations on 3D process models. 6. Practice roughing of 3D surfaces, code generation and CAD database conversion as it relates to 3D modeling of the machining process. 7. Select and modify post processors to edit existing code.
<p>Major Topics:</p>	<p>I. PERFORMANCE EXPECTATIONS (2 hours, lecture)</p> <ol style="list-style-type: none"> A. Fundamental expectations of NC and CAM with emphasis on graphics programming B. Essential procedures <p>II. PERFORMANCE EXPECTATIONS (3 hours, lab)</p> <ol style="list-style-type: none"> A. Analyzing NC and CAM B. Examining graphics programming <p>III. 2D VERSUS 3D FUNCTIONS (2 hours, lecture)</p> <ol style="list-style-type: none"> A. Translate 3D B. Geometry between planes <p>IV. 2D VERSUS 3D FUNCTIONS (3 hours, lab)</p> <ol style="list-style-type: none"> A. Translate 3D

B. Geometry between planes

V. WORKPLANES AND THEIR OPERATION (4 hours, lecture)

- A. Construction planes
- B. Tool planes

VI. WORKPLANES AND THEIR OPERATION (6 hours, lab)

- A. Construction planes
- B. Tool planes

VII. OVERVIEW OF 3D GEOMETRY FOR 3D SURFACES (4 hours, lecture)

- A. Considerations for beginning surface model
- B. Geometry
- C. Surfaces

VIII. OVERVIEW OF 3D GEOMETRY FOR 3D SURFACES (6 hours, lab)

- A. Considerations for beginning surface model
- B. Geometry
- C. Surfaces

IX. CREATING SURFACE MESHES (3 hours, lecture)

- A. Geometrical surfaces
- B. Free form surfaces

X. CREATING SURFACE MESHES (7 hours, lab)

- A. Geometrical surfaces
- B. Free form surfaces

XI. MACHINING OF 3D SURFACE MESHES (2 hours, lecture)

- A. Roughing operations
- B. Finishing operations

XII. MACHINING OF 3D SURFACE MESHES (3 hours, lab)

- A. Roughing operations
- B. Finishing operations

XIII. EDITING AND BLENDING SURFACE MESHES, ROUGHING OPERATIONS FOR 3D (4 hours, lecture)

- A. Fillet surfaces
- B. Blend surfaces

XIV. EDITING AND BLENDING SURFACE MESHES, ROUGHING OPERATIONS FOR 3D (6 hours, lab)

- A. Fillet surfaces
- B. Blend surfaces

XV. CAD DATABASE CONVERSION AS RELATES TO 3D (3 hours, lecture)

- A. Standard for the Exchange of Product (STEP) Model Data
- B. Initial Graphics Exchange Standard (IGES)
- C. Neutral File Format (NATIVE)

XVI. CAD DATABASE CONVERSION AS RELATES TO 3D (4 hours, lab)

- A. STEP Model Data
- B. IGES
- C. NATIVE

XVII. 4th AXIS MACHINING (3 hours, lecture)

- A. 4 axis drill path
- B. 4 axis milling path

XVIII. 4th AXIS MACHINING (4 hours, lab)

- A. 4 axis drill path
- B. 4 axis milling path

XIX. SIMULTANEOUS ROTARY MACHINING (3 hours, lecture)

- A. Axis substitute
- B. Rotary positioning

XX. SIMULTANEOUS ROTARY MACHINING (4 hours, lab)

- A. Axis substitute
- B. Rotary positioning

XXI. LATHE TURNING OPERATIONS (3 hours, lecture)

- A. Post processors
- B. Plane selection
- C. Lathe operations

XXII. LATHE TURNING OPERATIONS (4 hours, lab)

- A. Post processors
- B. Plane selection
- C. Lathe operations

XXIII. CODE GENERATION CONSIDERATIONS FOR 3D (3 hours, lecture)

	<p>A. Step over amount B. Scallop height</p> <p>XXIV. CODE GENERATION CONSIDERATIONS FOR 3D (4 hours, lab)</p> <p>A. Step over amount B. Scallop height</p>
Total Lecture Hours:	36
Total Laboratory Hours:	54
Total Hours:	90
Primary Method of Evaluation:	3) Skills demonstration
Typical Assignment Using Primary Method of Evaluation:	Create a 3D model of the print specified. Create a 3-axis machining process to manufacture on a CNC machining center from the engineering specifications provided. Run the verify software to correct any errors in the post . Submit process model with all necessary process sheets, and manuscripts to the instructor electronically.
Critical Thinking Assignment 1:	Provided with 3D wireframe CAD drawing, on CNC software, correct surface types, create a surface rough, finish toolpath and post for Haas CNC machining center g-code program. Submit project to the instructor via flash drive or email.
Critical Thinking Assignment 2:	Develop complete manufacturing procedures on CNC software for a CNC turning center operation, including tool descriptions and setup instructions. Submit project to the instructor electronically.
Other Evaluation Methods:	<p>Performance Exams Other Exams Class Performance Multiple Choice Completion Matching Items True/False Other (specify): Portfolio Part Programming</p>
Instructional Methods:	<p>Demonstration Lab Lecture</p>
If other:	
Work Outside of Class:	<p>Study</p> <p>Required reading</p> <p>Problem solving activities</p>
If Other:	
Up-To-Date Representative Textbooks:	Caminstructor. <u>Mastercam 2024 - Mill 3D Training Guide</u> . Caminstructor. 2024.
Alternative Textbooks:	

Required Supplementary Readings:	
Other Required Materials:	Flash Drive - removable memory media
Requisite:	Prerequisite
Category:	sequential
Requisite course(s): List both prerequisites and corequisites in this box.	Machine Tool Technology-10J
Requisite and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s).	<p>Knowledge of computer operating system commands to obtain listings, create files, delete files, load and save files.</p> <p>MTT 10J - Utilize computer operating systems to manipulate files and obtain listings and graphic plots.</p> <p>Ability to create 2D interactive graphics geometry such as points, lines, circles and splines.</p> <p>MTT 10J - Create geometric elements such as points, lines, circles and splines using interactive graphic techniques.</p> <p>Ability to convert geometry from CAD databases to numerical control part geometry.</p> <p>MTT 10J - Convert geometry from CAD databases to numerical control part geometry.</p> <p>Ability to design interactive graphics tool motion routines to drill, turn, bore, mill, profile and pocket.</p> <p>MTT 10J - Create tool motion routines including: turning, boring, drilling, profiling, pocket roughing and turning, using interactive graphic techniques.</p> <p>Understand geometry and tool motion routines using interactive graphic techniques.</p> <p>MTT 10J - Edit geometry, tooling statements and tool motion routines using interactive graphic techniques.</p>
Requisite Skill:	
Requisite Skill and Matching Skill(s): Bold the requisite skill(s). If applicable	
Requisite course:	
Requisite and Matching skill(s): Bold the requisite skill. List the corresponding	

course objective under each skill(s).	
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Enrollment Limitations and Category:	
Enrollment Limitations Impact:	
Course Created by:	Alice Greening/Jerry Kinnan
Date:	09/01/1994
Original Board Approval Date:	11/21/1994
Last Reviewed and/or Revised by:	Victor De La Torre
Date:	06/06/2022
Last Board Approval Date:	04/15/2024 effective FALL 2025