CAM250 : 4th Axis Machining

General Information

Author:	• Jorge Palma
Course Code (CB01) :	CAM250
Course Title (CB02) :	4th Axis Machining
Department:	CAM
Proposal Start:	Spring 2025
TOP Code (CB03) :	(0956.00) Manufacturing and Industrial Technology
CIP Code:	(15.0613) Manufacturing Engineering Technology/Technician.
SAM Code (CB09) :	Advanced Occupational
Distance Education Approved:	No
Will this course be taught asynchronously?:	No
Course Control Number (CB00) :	CCC000606926
Curriculum Committee Approval Date:	05/22/2024
Board of Trustees Approval Date:	07/16/2024
Last Cyclical Review Date:	05/22/2024
Course Description and Course Note:	CAM 250 is an advanced computer numerical control (CNC) course on multi-axis programming that introduces 4th axis machining concepts. Programming of rotary axis positioning for both vertical axis and horizontal axis machines are covered. Students practice CNC machining by programming simultaneous 4th axis and axis substitution toolpaths using Mastercam software.
Justification:	Mandatory Revision
Academic Career:	• Credit
Mode of Delivery:	
Author:	
Course Family:	

Academic Senate Discipline

Primary Discipline:	• Machine Tool Technology (Tool and die making)
Alternate Discipline:	• Manufacturing Technology (Quality control, process control)
Alternate Discipline:	No value

Course Development

Basic Skill Status (CB08)

Course is not a basic skills course.

☐ Allow Students to Gain Credit by Exam/Challenge

Course Special Class Status (CB13)

Course is not a special class.

Pre-Collegiate Level (CB21)

Not applicable.

Grading Basis

- Grade with Pass / No-Pass Option

Course Support Course Status (CB26)

Course is not a support course

General Education and C-ID

General Education Status (CB25)

Not Applicable

Transferability

Transferable to CSU only

Transferability Status

Approved

Units and Hours

Summary

Minimum Credit Units (CB07)	3
Maximum Credit Units (CB06)	3
Total Course In-Class (Contact) Hours	126
Total Course Out-of-Class Hours	36
Total Student Learning Hours	162

Credit / Non-Credit Options

Course Type (CB04)

Credit - Degree Applicable

Noncredit Course Category (CB22)

Credit Course.

Noncredit Special Characteristics

No Value

Course Classification Code (CB11)

Credit Course.

☐ Variable Credit Course

Funding Agency Category (CB23)

Not Applicable.

☐ Cooperative Work Experience Education Status (CB10)

Weekly Student Hours

	In Class	Out of Class
Lecture Hours	1	2
Laboratory Hours	6	0
Studio Hours	0	0

Course Student Hours

Course Duration (Weeks)	18
Hours per unit divisor	54
Course In-Class (Contact) Hours	
Lecture	18
Laboratory	108
Studio	0

Total	126

Course Out-of-Class Hours

Lecture	36
Laboratory	0
Studio	0
Total	36

Time Commitment Notes for Students

No value

Units and Hours - Weekly Specialty Hours

Activity Name	Type	In Class	Out of Class
No Value	No Value	No Value	No Value

Pre-requisites, Co-requisites, Anti-requisites and Advisories

Prerequisite

CAM210 - Computer Aided Manufacturing Basic Milling (in-development)

Objectives

- Perform basic interpretation of geometric shapes and translate them into the proper numeric format.
- Explain the safety measures employed during the operation of a Computer Numerical Control (CNC) mill.
- Perform basic cutting procedures using a CNC mill.
- Identify the basic principles required to successfully complete a simple project.
- Differentiate between absolute and incremental positioning.
- Explain and identify the work offset (part zero).

OR

Prerequisite

CAM220 - Computer Aided Manufacturing, Basic Lathe (in-development)

Objectives

- Perform basic interpretation of geometric shapes and translate them into the proper numeric format.
- Explain the safety measures employed during the operation of a Computer Numerical Control (CNC) lathe.
- Perform basic cutting procedures using a CNC lathe.
- Identify the basic principles required to successfully complete a simple project.
- Differentiate between absolute and incremental positioning.
- Explain and identify the work offset (part zero).

AND

Advisory

ENGR102 - Engineering Print Reading For Industry (in-development)

Objectives

- Read dimensions to determine the size of a feature in a drawing.
- Explain model-based design and electronic 3D print reading.
- Interpret technical blueprints including machine shop methods for forming and finishing metals, including holes and gears.

Entry Standards

Entry Standards

Course Limitations

Cross Listed or Equivalent Course

Specifications

Methods of Instruction

Methods of Instruction	Lecture
Methods of Instruction	Laboratory
Methods of Instruction	Multimedia
Methods of Instruction	Demonstrations
Methods of Instruction	Presentations

Out of Class Assignments

- Calculations (e.g. given material properties and dimensions of a work piece, calculate acceptable rotational tool speeds)
- Individual project (e.g. create a part program from a blueprint drawing)
- Group project (e.g. create part programs from solid models)

Methods of Evaluation	Rationale
Exam/Quiz/Test	Quiz
Exam/Quiz/Test	Midterm exam
Exam/Quiz/Test	Laboratory practical exam (e.g. demonstration of safety procedures for operating the 4th axis CNC machines)
Exam/Quiz/Test	Final project (e.g. inspection of a complex part machined on the 4th axis CNC machine)

Textbook Rationale

No Value

Textbooks

Author	Title	Publisher	Date	ISBN
Michael Fitzpatrick	Machining and CNC Technology	McGraw-Hill	2019	9781259827440

Other Instructional Materials (i.e. OER, handouts)

No Value

Materials Fee

No value

Learning Outcomes and Objectives

Course Objectives

Create planes and toolpaths for 4 axis machining.

Set up a 4 axis Computer Numerical Control (CNC) machine.

Employ setup tools.

Demonstrate 4 axis drilling.

Practice 4 axis substitution.

Evaluate the geometry of a part.

Interpret 4 axis positioning.

SLOs

Prepare a 4th axis CNC machine and troubleshoot a CNC program. Expected Outcome Performance: 70.0

ILOs Core ILOs	Analyze and solve problems using critical, logical, and creative thinking; ask questions, pursue a line of inquiry, and derive conclusions; cultivate creativity that leads to innovative ideas.
	Demonstrate depth of knowledge in a course, discipline, or vocation by applying practical knowledge, skills, abilities, theories, or methodologies to solve unique problems.
CAM A.S. Computer Numerical Control Technician	Apply various software programs to write CNC code for the production of manufactured parts.

Design efficient programming with Mastercam for effective and safe 4th axis CNC machining. Expected Outcome Performance: 70.0

ILOs Core ILOs	Analyze and solve problems using critical, logical, and creative thinking; ask questions, pursue a line of inquiry, and derive conclusions; cultivate creativity that leads to innovative ideas.
	Demonstrate depth of knowledge in a course, discipline, or vocation by applying practical knowledge, skills, abilities, theories, or methodologies to solve unique problems.
CAM A.S. Computer Numerical Control Technician	Apply various software programs to write CNC code for the production of manufactured parts.
	Discuss the techniques used to read and evaluate an engineering drawings.

Create a part using a 4th axis CNC machine verifying the machining process. Expected Outcome Performance: 70.0

ILOs Core ILOs	Analyze and solve problems using critical, logical, and creative thinking; ask questions, pursue a line of inquiry, and derive conclusions; cultivate creativity that leads to innovative ideas.
	Demonstrate depth of knowledge in a course, discipline, or vocation by applying practical knowledge, skills, abilities, theories, or methodologies to solve unique problems.
CAM A.S. Computer Numerical Control Technician	Apply various software programs to write CNC code for the production of manufactured parts.
	Use manual machine and CNC machine tools to produce manufactured parts.

Additional SLO Information

Does this proposal include revisions that might improve student attainment of course learning outcomes?

No

Is this proposal submitted in response to learning outcomes assessment data?

No

If yes was selected in either of the above questions for learning outcomes, explain and attach evidence of discussions about learning outcomes.

No Value

SLO Evidence

No Value

Course Content

Lecture Content

Introduction (3 hours)
- History of CNC programming and machining
- Review of machining basics
- Preparation of CNC machining

Safety and Sustainability (2 hours)
- Shop safety
- Personal protection equipment (PPE)
- Recycling of material
- Designing toolpaths for minimum material waste and maximum time and energy savings

4th Axis Machining Setup in Mastercam (2 hours)
- Setting up Mastercam configuration
- Orientation of the part
- Part zero in Mastercam
- Tool zero in Mastercam

4th Axis Positioning (2 hours)
- Creating planes
- Setting up tools
- Applying the toolpath
- Clearance plane

Simultaneous 4th Axis Toolpath (3 hours)
- Creating curves
- Unwrapping the cylinder
- Axis substitution
- Roll die toolpath
- Creating solids for fixturing
- Radial cutting
- Defining lead and lag angles
- Roughing with an axial cut

4th Axis Drilling (2 hours)
- Creating hole geometry
- Creating hole axes
- 4th axis drilling toolpath
- Setting up clearance plane
- Retract plane

Horizontal 4th Axis Machining (2 hours)
- Setting up solid parts in Mastercam
- Using planes
- Creating custom planes
- Clearance plane
- Machining on tombstones (pedestal-type fixtures)

- Setting up parts on tombstones

Setting Up a 4th Axis CNC Machine (2 hours)
- Loading the rotary table on the machine
- Indicating on the rotary table
- Finding the center of rotation
- Finding part zero
- Setup tools such as dial indicators
- Machine simulation
- Verification and running

Total hours: 18

Laboratory/Studio Content

Safety and Sustainability (4 hours)
- Shop safety
- Personal protection equipment (PPE)
- Recycling of material
- Designing toolpaths for minimum material waste and maximum time and energy savings

4th Axis Machining Setup in Mastercam (16 hours)
- Setting up Mastercam configuration
- Orientation of the part
- Part zero in Mastercam
- Tool zero in Mastercam

4th Axis Positioning (16 hours)
- Creating planes
- Setting up tools
- Applying the toolpath
- Clearance plane

Simultaneous 4th Axis Toolpath (18 hours)
- Creating curves
- Unwrapping the cylinder
- Axis substitution
- Roll die toolpath
- Creating solids for fixturing
- Radial cutting
- Defining lead and lag angles
- Roughing with an axial cut

4th Axis Drilling (18 hours)
- Creating hole geometry
- Creating hole axes
- 4th axis drilling toolpath
- Setting up clearance plane
- Retract plane

Horizontal 4th Axis Machining (18 hours)
- Setting up solid parts in Mastercam
- Using planes
- Creating custom planes
- Clearance plane
- Machining on tombstones (pedestal-type fixtures)
- Setting up parts on tombstones

Setting Up a 4th Axis CNC Machine (18 hours)
- Loading the rotary table on the machine
- Indicating on the rotary table
- Finding the center of rotation
- Finding part zero
- Setup tools such as dial indicators
- Machine simulation
- Verification and running

Total hours: 108

Additional Information

Is this course proposed for GCC Major or General Education Graduation requirement? If yes, indicate which requirement in the two areas provided below.

No

GCC Major Requirements

No Value

GCC General Education Graduation Requirements

No Value

Repeatability

Not Repeatable

Justification (if repeatable was chosen above)

No Value

Resources

Did you contact your departmental library liaison?

No

If yes, who is your departmental library liason?

No Value

Did you contact the DEIA liaison?

No

Were there any DEIA changes made to this outline?

No Value

If yes, in what areas were these changes made:

No Value

Will any additional resources be needed for this course? (Click all that apply)

No Value

If additional resources are needed, add a brief description and cost in the box provided.

No Value