

CAM260 : Introduction to 5-Axis Machining

General Information

Author:	<ul style="list-style-type: none">Jorge Palma
Course Code (CB01) :	CAM260
Course Title (CB02) :	Introduction to 5-Axis Machining
Department:	CAM
Proposal Start:	Spring 2025
TOP Code (CB03) :	(0956.30) Machining and Machine Tools
CIP Code:	(48.0501) Machine Tool Technology/Machinist.
SAM Code (CB09) :	Advanced Occupational
Distance Education Approved:	No
Will this course be taught asynchronously?:	No
Course Control Number (CB00) :	CCC000626216
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 260 introduces 5-Axis machining concepts that explores both surface (solid face) and wireframe-based toolpaths. Different methods of tool axis control, and different titling strategies are covered. Special attention is paid to collision control techniques. Multi-axis machining is becoming increasingly important to make difficult parts with high precision.
Justification:	Mandatory Revision
Academic Career:	<ul style="list-style-type: none">Credit
Mode of Delivery:	
Author:	
Course Family:	

Academic Senate Discipline

Primary Discipline:	<ul style="list-style-type: none">Machine Tool Technology (Tool and die making)
Alternate Discipline:	No value
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)	4
Maximum Credit Units (CB06)	4
Total Course In-Class (Contact) Hours	180
Total Course Out-of-Class Hours	36
Total Student Learning Hours	216

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	9	0
Studio Hours	0	0

Course Student Hours

Course Duration (Weeks)	18
Hours per unit divisor	0
Course In-Class (Contact) Hours	
Lecture	18
Laboratory	162
Studio	0

Total 180

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

Advisory

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

Advisory

CAM250 - 4th Axis Machining (in-development)

Objectives

- Create planes and toolpaths for 4 axis machining.
- Set up a 4 axis Computer Numerical Control (CNC) machine.
- Demonstrate 4 axis drilling.

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 Discussion

Methods of Instruction Multimedia

Methods of Instruction Demonstrations

Out of Class Assignments

- Create a part program using a blue print, then save it in a Mastercam file and upload the file to canvas
- Create a part program for each solid model, save it in a Mastercam file and then upload the file to canvas

Methods of Evaluation

Rationale

Exam/Quiz/Test

Quizzes

Exam/Quiz/Test

Final exam

Exam/Quiz/Test

Final project (e.g. set-up and complete machining of a manifold)

Textbook Rationale

2009 is the latest edition of this book

Textbooks

Author	Title	Publisher	Date	ISBN
Karlo Apro	Secrets of 5-Axis Machining	Industrial Press	2009	9780831133757

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

No Value

Materials Fee

No value

Learning Outcomes and Objectives

Course Objectives

Explain the steps for 5-Axis toolpath creation.

Identify the zero position on a 5-Axis machine.

Create various 5-Axis planes.

Perform 5-Axis drilling.

Select machine configurations.

Measure 5-axis centerline manually.

SLOs

Operate a variety of complex Multi-Axis Computer Numerical Control machines to create high precision parts while following industry safety standards.

Expected Outcome Performance: 70.0

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.

ILOs
Core ILOs

Demonstrate depth of knowledge in a course, discipline, or vocation by applying practical knowledge, skills, abilities, theories, or methodologies to solve unique problems.

Evaluate best processes to efficiently manufacture parts with minimum environmental impact.

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

Discuss the techniques used to read and evaluate an engineering drawings.

Employ various software tools while integrating traditional methods of programming and controlling the machining process for effective set-up, troubleshooting and finishing.

Expected Outcome Performance: 70.0

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.

ILOs
Core ILOs

Demonstrate depth of knowledge in a course, discipline, or vocation by applying practical knowledge, skills, abilities, theories, or methodologies to solve unique problems.

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 multi-axis machining
- Definition of multi-axis
- Benefits of 5-Axis and multi-axis machining

5-Axis machining Set-up in Mastercam (3 hours)

- Setting up Mastercam configuration
- Orientation of the part
- Part zero in Mastercam
- Tool zero in Mastercam

3+2 Machining (3 hours)

- Creating planes
- Tool set-up
- Apply toolpath
- Clearance plane
- Creating solids for fixturing

Simultaneous 5-Axis Toolpath (3 hours)

- Creating curves
- Setting up proper planes
- Tool axis control
- Cut pattern
- Collision control
- Defining lead/lag angle
- Defining side tilt angle

5-Axis Drilling (3 hours)

- Creating hole geometry
- Creating hole axis vector line
- 5-Axis drilling toolpath
- Setting up clearance plane
- Retracting plane

5-Axis Trunnion Set-up (3 hours)

- Loading the rotary table on the machine
- Indicate the rotary table
- Finding center of rotation
- Finding part zero
- Setting up tools
- Machine simulation
- Verify and run part

Total hours: 18

Laboratory/Studio Content

Introduction (2 hours)

- History of multi-axis machining
- Definition of multi-axis
- Benefits of 5-Axis and multi-axis machining

5-Axis machining Set-up in Mastercam (32 hours)

- Setting up Mastercam configuration
- Orientation of the part
- Part zero in Mastercam
- Tool zero in Mastercam

3+2 Machining (32 hours)

- Creating planes
- Tool set-up
- Apply toolpath
- Clearance plane
- Creating solids for fixturing

Simultaneous 5-Axis Toolpath (32 hours)

- Creating curves
- Setting up proper planes
- Tool axis control
- Cut pattern
- Collision control
- Defining lead/lag angle
- Defining side tilt angle

5-Axis Drilling (32 hours)

- Creating hole geometry
- Creating hole axis vector line
- 5-Axis drilling toolpath
- Setting up clearance plane
- Retracting plane

5-Axis Trunnion Set-up (32 hours)

- Loading the rotary table on the machine
- Indicate the rotary table
- Finding center of rotation
- Finding part zero
- Setting up tools
- Machine simulation
- Verify and run part

Total hours: 162

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 liaison?

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