# MET-1410: COMPUTER AIDED MANUFACTURING PROCESSES

## Cuyahoga Community College

### Viewing: MET-1410 : Computer Aided Manufacturing Processes

**Board of Trustees:**

March 2021

**Academic Term:**

Fall 2021

**Subject Code**

MET - Mech Eng/Manuf Ind Eng Tech

**Course Number:**

1410

**Title:**

Computer Aided Manufacturing Processes

**Catalog Description:**

Manual and application of CAD/CAM technology to program CNC machines to produce mechanical parts. Covers manually writing paths programs; 2D and 3D parts graphics designs; generating CNC programs from graphics; verifying toolpaths by simulation and post-processing path programs to work on given CNC controllers; set-up CNC lathes and milling machines to perform machining operations; operate CNC machines to produce parts.

**Credit Hour(s):**

3

**Lecture Hour(s):**

2

**Lab Hour(s):**

3

## Requisites

**Prerequisite and Corequisite**

MET-1240 Machine Tools and Manufacturing Processes, or concurrent enrollment; or MET-123B 2D AutoCAD and MET-1340 Introduction to Industry 4.0 Vision System for students in Smart Manufacturing program; or departmental approval: relevant work experience.

## Outcomes

**Course Outcome(s):**

Apply the fundamentals of CNC programming to analyze blueprints; plan, write, troubleshoot and edit CNC programs for given controllers.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. Explain the principle, application and advantage of CNC.
2. Perform hand operations such as inching, traversing, and positioning.
3. Apply absolute and incremental methods to place entries on sheets using rules for block format.
4. Recognize error alarms and take corrective action.
5. Verify and validate tool paths by graphical simulation
6. Identify and select tools.
7. Set up CNC machines for machining operations.

**Course Outcome(s):**

Operate CNC lathe or milling machines to produce engineering parts.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. Write path's program to turning and milling.
2. Recognize error alarms and take corrective action.
3. Load, edit, and save program.
4. Identify and select tools.
5. Select feed, cutting speed and cuts.
6. Set up CNC machines for machining operations.

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**Course Outcome(s):**

Apply safety principles in using CNC Machines to operate machines safely and efficiently.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. Explain the principle, application and advantage of CNC.
2. Perform hand operations such as inching, traversing, and positioning.
3. Recognize error alarms and take corrective action.

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**Course Outcome(s):**

Apply CAD/CAM technology to program CNC machines for the manufacture of engineering parts.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. Recognize and observe the safety precautions in interfacing CAD/CAM system with CNC machines.
2. Differentiate between direct and graphic based CNC programming.
3. Interpret parts models.
4. Produce 2D part graphics; and 3D wireframe, solid, and surface parts models
5. Select appropriate tooling and determine the desired spindle speed, feed-rate, and other machining parameters required to accomplish operations simulations, verifications and CNC code generation from graphics and models.
6. Generate path program (G-codes and M-codes) and postprocess them for a given CNC controller type: FANUC, MAZAK, OKUMA, etc.
7. Verify path programs by simulation.
8. Download path program to the Machine Control Unit (MCU).
9. Set up parts for machining, determining tools, offsets, establishing work-zero, and tools change positions.
10. Run CNC milling machine or lathe to produce part.

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**Methods of Evaluation:**

1. Lab reports, program sheets and work-piece inspection
2. Models inspection
3. Simulation analysis
4. Quizzes
5. Midterm examination
6. Final examination

**Course Content Outline:**

1. CONCEPTS
    a. CNC machines description
    b. Tool-holder positions
    c. Working data
    d. Cutting values
    e. Hand operation techniques
    f. Operating elements
    g. Traverse indication
    h. +, - signs
    i. Inching operation
    j. Cutting off power
    k. Positioning tools
    l. CNC Operation
    m. Operating elements
    n. Metric/inch units conversion
    o. CNC-main elements
    p. Kinds of programs
    q. Geometrical information
    r. Feed and speed
    s. G-functions
    t. Format
    u. Programming
    v. Positioning
    w. Fixed cycle
    x. Interpolations
    y. Threading
    z. Control of dimensions
    aa. Program input
    bb. Input formats
    cc. Inputting data
    dd. Program input
    ee. Figure keys, word display, memory key, delete key
    ff. Errors
    gg. Causes
    hh. Corrective measures
    ii. Running program
    jj. Positions of tool-holders
    kk. Turning and milling tools, etc.
    ll. Machine tooling and fixturing
    mm. Creating 2D Geometry
        i. Steps to creating 2D geometry
        ii. Open a new file
        iii. Create a rectangle
        iv. Use screen-zoom tool
        v. Delete geometry
        vi. Create a round (fillet)
        vii. Create and trim the bottom notch
        viii. Create a point, arc (circle)
        ix. Create point patterns using the bolt circle and grid options
        x. Add dimensions
        xi. Analyze the part
    nn. Creating 3D geometry
        i. Steps to creating 3D geometry
        ii. Change perspective of the part
        iii. Translate geometry in the Z direction
        iv. Change the plane

v. Create geometry in the side and top planes
vi. Translate entities without linking
vii. Create pocket geometry
viii. Create new and custom planes
ix. View new and custom planes
x. Create circle on new and custom planes
xi. Translate circle in the Z direction
xii. Trim the circle
xiii. Translate arc to complete angled slot
xiv. Create 3D dimensions

oo. Creating surface geometry
i. Steps to creating surface geometry
ii. Create planar surface using existing wireframe geometry
iii. Trim planar surface
iv. Remove existing boundaries
v. Create a lofted surface
vi. Create a surface using the Sweep tool
vii. One last sweep

pp. Importing existing geometry
i. Steps to importing existing geometry
ii. Pull IGES file off internet
iii. Open IGES file
iv. Translate the imported part to Mastercam Axis System
v. Rotate part 90 degrees
vi. Shade surfaces.

qq. Creating a job setup
i. Steps in creating a job setup
ii. Know and understand all part requirements
iii. Review the part and plan the milling process
iv. Create the raw stock

rr. Creating facing toolpaths
i. Steps in creating facing toolpaths
ii. Define the facing plane
iii. Define the tooling parameters
iv. Tooling operations
v. Modify an existing toolpath
vi. Verify the Facing toolpath

ss. Creating contouring toolpaths
i. Steps to creating the contour toolpath
ii. Check the facing toolpath
iii. Create the basic contour toolpath
iv. Modify the contour toolpath

tt. Creating pocket toolpaths
i. Steps to creating pocket toolpaths
ii. Create the basic pocket toolpath
iii. Create the open pocket toolpath
iv. Create the island pocket toolpath

uu. Creating drill/surface toolpaths
i. Steps to creating drill cycle toolpaths
ii. Create the bolt circle drill toolpaths
iii. Create the grid drill toolpath
iv. Create the surface toolpath
v. Final toolpath - face off excess material
vi. Final analysis
vii. Post it
viii. The setup sheet

2. SKILLS

a. Perform the four arithmetic operations on whole numbers, arithmetic fractions, and decimal fractions
b. Identify the relationships in geometric figures
c. Convert between the metric and English measurement systems and convert within each system
d. Employ various techniques to recognize and use applicable vocabulary
e. Read and write “G- and M-codes” Fanuc
f. Compute feeds and speeds for appropriate materials
g. Set up and operate a CNC mill in a safe and efficient manner
h. Operate milling machines
i. Read blueprints
j. Model parts in 2D, 3D wireframe , 3D surfaces, solid geometry
k. Setup models for CNC toolpaths generation
l. Machine parts by simulation
m. Verify and validate toolpaths by solid graphical simulation
n. Troubleshoot and edit toolpaths
o. Generate and postprocess toolpath readable by FANUC controllers.

3. ISSUES
   a. Equipment sufficiency
   b. Safety in Operation of CNC machines
   c. CNC interface program updates
   d. Networking for direct programs transfer
   e. Equipment sufficiency
   f. Safety in operation of CNC machines

## Resources

Lin, S. C. Jonathan. *Computer Numerical Control: From Programming to Networking.* Albany, 1997.

Lynch, Mike. *Fundamentals of Computer Numerical Controls (CNC).* CNC Concepts, Inc, 2000.

Lynch, Mike. *Fundamentals of Computer Numerical Controls (CNC)Workbook.* CNC Concepts, Inc, 2000.

Curran, Kelly and Jon Stenerson. *Computer Numerical Control: CNC Machining and Turning Center Operation and Programming.* 3rd ed. Upper Saddle River, Nj., 2016.

Quesada, Robert. *Computer Numerical Control: Machining and Turning Centers.* Upper Saddle River, Nj., 2005.

Evans, Ken. *Programming of CNC Machines.* 4th. Industrial Press, Inc, 2016.

Mattson, Michael. (2010) *CNC Programming: Principles and Applications,*Clifton Park, NY: Delmar.

Groover, Mikell. *Automation, Production Systems, and Computer-Integrated Manufacturing.* 4th ed. Boston, MA: Pearson, 2015.

**Resources Other**

1. *Journal Of Manufacturing Science and Engineering* http://manufacturingscience.asmedigitalcollection.asme.org/journal.aspx 2018
2. Handouts.
3. CNC programming tutorials/software.
4. *Journal Of Manufacturing Science and Engineering* http://manufacturingscience.asmedigitalcollection.asme.org/journal.aspx 2018.
5. Mastercam V9 Workbook by Richard Cozzens
6. Software: Mastercam
7. Machine and software manuals.

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