Course Outline

General Information

COURSE ID (CB01A AND CB01B)

DMT 84A

COURSE TITLE (CB02)

Introduction to CNC Programming and Operation; Mill

COURSE CREDIT STATUS

Credit - Degree Applicable

EFFECTIVE TERM

Fall 2023

COURSE DESCRIPTION

Introduction to mill tool path programming using G & M code format. CNC systems and components including machine controller functions and operations. Program entry, editing, and verification. Calculation for mill cutter compensation. Precision inspection techniques. Basic mill setups, including cutting tool selection, and work holding.

FACULTY REQUIREMENTS

COURSE FAMILY

Not Applicable

Course Justification

Introduction to CNC is a major employment preparation CTE course for our Design and Manufacturing Technologies day and evening programs. It is a CSU transferable course. It is intended to better prepare students for work in the manufacturing and machining industry in the area of CNC programming, set up, and operation as advised by our industry advisory committee. This course is also part of the CNC Machinist degree and certificate in the Design and Manufacturing Technologies program.

Foothill Equivalency

DOES THE COURSE HAVE A FOOTHILL EQUIVALENT?

No

FOOTHILL COURSE ID

Formerly Statement

FORMERLY STATEMENT	(Formerly MCNC 75A.)

Course Development Options

BASIC SKILL STATUS (CB08)

Course is not a basic skills course.

GRADE OPTIONS

- Letter Grade
- Pass/No Pass

REPEAT LIMIT

0

Transferability & Gen. Ed. Options

Information below is subject to change. For the official listing of courses, their approval dates, and transfer credit limitations, check the De Anza catalog (by academic year), ASSIST.ORG (https://assist.org/) and C-ID.NET (https://c-id.net/).

TRANSFERABILITY

Transferable to CSU only

Units and Hours

Summary

MINIMUM CREDIT UNITS	5.0
MAXIMUM CREDIT UNITS	5.0

Weekly Student Hours

Type	In Class	Out of Class
Lecture Hours	3.0	6.0
Laboratory Hours	6.0	0.0

Course Student Hours

COURSE DURATION (WEEKS)

12.0

HOURS PER UNIT DIVISOR

36.0

Course In-Class (Contact) Hours

LECTURE

36.0

LABORATORY

72.0

TOTAL

108.0

Course Out-of-Class Hours

LECTURE

72.0

LABORATORY

0.0

NA

0.0

TOTAL

72.0

Prerequisite(s)

Corequisite(s)

Advisory(ies)

- ESL 261 and ESL 265, or ESL 461 and ESL 465, or eligibility for EWRT 1A or EWRT 1AH or ESL 5
- Pre-algebra or equivalent (or higher), or appropriate placement beyond pre-algebra

DMT 80 or experience in machining processes

Limitation(s) on Enrollment

Entrance Skill(s)

General Course Statement(s)

Methods of Instruction

Lecture and visual aids
Discussion of assigned reading Discussion and problem solving performed in class Quiz and examination review performed in class Laboratory discussion sessions and quizzes that evaluate the proceedings weekly laboratory exercises

Assignments

A. Lab projects demonstrating mastery of skills using three axis CNC machines, simulators and verification software covered in this course.
B. Take home and in class worksheets involving feeds, speeds, and cartesian coordinate calculations.
C. Reading from textbooks and references.

Methods of Evaluation

A. Exams covering lecture and lab material relating to CNC machine tool programming and operation. Evaluation based on completeness and accuracy of word address programs and related CNC machine set-up and operation.
B. Completion and accuracy of take home worksheets with emphasis on use of correct speed/feed formulas and coordinate calculations from drawings.
C. Manufacturing rubric used to evaluate and inspect laboratory projects and exercises.
D. A comprehensive, final exam that requires students to critically analyze and apply concepts examined throughout the course.

Essential Student Materials/Essential College Facilities

Essential Student Materials:
- None.

Essential College Facilities:
- CNC machine tool manufacturing lab

Examples of Primary Texts and References

Author	Title	Publisher	Date/Edition	ISBN
Schmid, Peter,"CNC Programming Handbook, Third Edition", New York, New York: Industial Press, 2008				
DMT Staff: "Design and Manufacturing Technologies 84A Syllabus" De Anza College, Cupertino, CA, 2018.				

Examples of Supporting Texts and References

Author	Title	Publisher
Mattson, Mike: "CNC Programming Principles and Applications Second Edition", Albany, New York: Delmar Publishing, 2009		

Learning Outcomes and Objectives

Course Objectives

- Describe three axis CNC milling machines.
- Select and calculate logical tool paths and positioning for mill cutters.
- Prepare basic three-axis programming for milling machine operations
- Operate mill CNC controller to download and dry run part programs
- Describe mill setup procedures for work piece and fixture offsets
- Apply the use of precision measuring tools to inspect the accuracy of machined parts
- Describe mill cutting tool materials; characteristics, and uses.
- Explain the common types and characteristics of CNC milling machine tooling.

CSLOs

- Demonstrate the set up and basic operation of vertical machining centers.
- Create basic word-address programs to successfully construct projects using vertical machining centers.

Outline

A. Describe three axis CNC milling machines.
    1. CNC milling machine types and applications.
    2. Numerical control components.
        a. Computer.
        b. Drive motor types.
        c. Close loop systems.
        d. Resolvers and encoders
    3. Feed mechanism types.
        a. Re-circulating ball screws.
        b. Pneumatic and hydraulic.
    4. Data mediums.
        a. One inch tape and floppy disks (historical reference).
        b. USB and direct file transfer
        c. Manual data input (MDI).
        d. Direct numerical control (DNC).

5. Controller programming formats.
    a. Word address, EIA/ISO standardized alphanumeric codes.
    b. Conversational.
6. Mill axis and machine interpretation.
    a. Cartesian coordinate system.
        1. X, Y, and Z axis designations.
        2. A, B, and C rotary axis designations.
    b. Point to point.
    c. Continuous path, contouring, linear and circular interpolation.
7. Methods of tool positioning.
    a. Cumulative (incremental).
    b. Coordinate (absolute).

B. Select and calculate logical tool paths and positioning for mill cutters.
1. Effective rough, semi-finish and finish cuts for productivity and accuracy.
    a. Rules for depth calculation.
    b. Close tolerance and thin wall applications.
2. Climb and conventional milling.
3. Pocket milling.
4. RPM and feed rate guidelines/calculations.
5. Cutter path development.
    a. Zero point selection.
        1. X and Y for symmetrical and non-symmetrical parts.
        2. Z locations and considerations.
    b. Mill cutter centerline calculations.
        1. Right triangle laws: computing unknown sides and angles; conversion of minutes/seconds to decimal degrees and decimal degrees to minutes/seconds; scientific calculator operation.
        2. Calculation of cutter compensation: definition of point, line, angle and arc; plot coordinate points for mill cutters (to form inside/outside square obtuse and oblique corners)(to form inside/outside corners with 90 degree arcs).

C. Prepare basic three-axis programming for milling machine operations
1. CNC program preparation.
    a. Basic prepatory and miscellaneous functions.
    b. Speed, feed and tool address.
    c. Tool coordinates.
        1. Circular interpolation: with I and J; with R.
        2. Slotting.
        3. Plunge milling methods: pre-drill; straight plunge or ramp.
        4. Bolt hole circles.
    d. Canned cycles with R plane.
        1. Drill cycle.
        2. Peck drill (fixed pitch).
        3. Counterbore.
        4. Use with L repeat command.
    e. Tool length offset.
    f. Cutter compensation.
        1. Climb/Conventional milling
        2. Ramp on/off moves
    g. Incremental and absolute.
2. Verify CNC programs by means of machine simulators and software verification tools.

D. Operate mill CNC controller to download and dry run part programs
1. Down load programs from PC or DNC.
2. Down load programs from floppy disk or USB
3. Review commonly used controller functions.
4. Use jog functions to accurately locate spindle.
5. Input and operate in MDI.
6. Call up and run programs in memory.
7. Run tool tryout with single block and adjusted feed rates.

E. Describe mill setup procedures for work piece and fixture offsets
1. Workpiece/fixture alignment.
2. Workholding procedures for accuracy.
3. Location and setting of workpiece/fixture zero.

F. Apply the use of precision measuring tools to inspect the accuracy of machined parts
1. Travel and test indicators.
    a. Parts, attachments.
    b. Setups, cosine error.
2. Gage blocks
    a. Classes
    b. Care
    c. Selecting blocks to build-up
    d. Wringing
3. Sine bar set-ups for angles.
    a. Calculate block build-up for angles.
    b. Calculate error of measured angle.

G. Describe mill cutting tool materials; characteristics, and uses.
1. Carbide
2. Coatings

3. Angles; relief and rake.

H. Explain the common types and characteristics of CNC milling machine tooling.
   1. Tool holders.
      a. Tapers, methods of securing.
      b. Retention stubs, lengths.
      c. Types.
         1. End mill, set screw clamping.
         2. Collet chucks, collet sizes.
         3. Tapping: floating (tension/compression); rigid.
         4. Stub arbors.
         5. Adapters: Morse; Jacobs; boring head.
   2. Workholding.
      a. Vise and stop.
      b. Strap and toe clamps.
      c. Collet and V-blocks.

Lab Topics

A. Multi - Axis CNC milling machine
B. Word address programming
C. CNC mill controller operations
D. CNC mill set up procedures
E. Measuring tools and Inspection
F. CNC milling tooling (cutting tools and holders)