I. Course Information

Course Acronym:* MTT

Course Number:* 10B

Descriptive Title:* Computer Numerical Control Programming

Division: Industry and Technology

Department:* Machine Tool Technology

Course Disciplines: Machine Tool Technology

Catalog Description:* This course covers the study of Computer Numerical Control (CNC) programming with emphasis on contouring, canned cycles, cutter diameter compensation, looping, macro subroutines and multiple part programming for three axis CNC milling machines and CNC lathes.

Conditions of Enrollment:

Prerequisite: Machine Tool Technology 10A or equivalent; Machine Tool Technology 40 or equivalent experience; and Machine Tool Technology 46 or 101 or equivalent experience with a minimum grade of C in each prerequisite course

Co-requisite:

Recommended Preparation:

Enrollment Limitation:

Course Length: Full Term

Hours Lecture (per week): 2.5

Hours Laboratory (per week): 1.5

Outside Study Hours:* 5

Total Course Hours:* 72

Course Units:* 3

Grading Method: Letter Grade only

Credit Status: Credit, degree applicable

Transfer CSU:	Yes	**Effective Date:**	Prior to July 1992
Transfer UC:	No	**Effective Date:**	
General Education: ECC			
Term:		**Other:**	
CSU GE:			
Term:		**Other:**	
IGETC:			
Term:		**Other:**	

II. Outcomes and Objectives

A. Student Learning Outcomes (SLOs) **(The course student learning outcomes are listed below.)**
SLO revisions are completed via the SLO Change Form available on the College Curriculum Committee website.

Student Learning Outcomes:

SLO #1 Inputting a Program

Student will input a program into a Computer Numerical Control (CNC) machine.

SLO #2 Write, Edit and Input Programs

Students will be able to write and alter word address programs for three-axis milling machines and input and edit programs into a CNC machine using manual input keyboard or local input.

SLO #3 Programming Routines & Loops

Students will be able to write word address programs using routines, loops and macro subroutines as well as perform simple contouringoperations on a CNC lathe.

B. Course Objectives **(The major learning objective for in this course are listed below.)**

Course Objectives:

1. Write word address programs for a three axis milling machine using linear and circular interpolation,canned cycles, special mill cycles, mirror image and metric capabilities.
2. Insert programs into a CNC machine or simulator using manual data input keyboard and local input.
3. Operate the local data input text input editor on a CNC machine or simulator in the command and text moes to create or alter programs.
4. Write word address programs using repetitive routines, loops and macro subroutines.
5. Write CNC programs in the extended word address format using polar coordinates, cutter diameter compensation, scaling and cutter path transformation.
6. Write word address programs to perform simple contouring machining operations on a CNC lathe.

III. Outline of Subject Matter

(Topics should be detailed enough to enable an instructor to determine the major areas that should be covered to ensure consistency from instructor to instructor and semester to semester.)
Example:

I. Main Topic (3 hours, lecture)
- **A. Sub topics**
- **B. Sub topics**
  - **1. Super sub topic**
  - **2. Super sub topic**

Major Topics:

I. CNC PROGRAMMING OVERVIEW (2 hours, lecture)

1. Review of CNC systems
2. Programming example

II. CNC PROGRAMMING OVERVIEW (1.5 hours, lab)

1. CNC systems review
2. Programming example

III. CONTINUOUS PATH PROGRAMMING FOR MILLS (10 hours, lecture)

1. Linear interpolation
    1. Cutter offsets
    2. 2-axis
    3. 3-axis
2. Circular interpolation
    1. Arc center offsets (incremental)
    2. Arc center offsets (absolute)
    3. I and J and R methods

IV. CONTINUOUS PATH PROGRAMMING FOR MILLS (5 hours, lab)

1. Linear interpolation
    1. Cutter offsets
    2. 2-axis
    3. 3-axis
2. Circular interpolation
    1. Arc center offsets (incremental)
    2. Arc center offsets (absolute)
    3. I and J and R methods

V. POINT TO POINT PROGRAMMING (3 hours, lecture)

1. Basic word address commands - review
    1. Sequence numbers
    2. Feedrate commands
    3. Spindle speed commands
    4. Miscellaneous functions
    5. Tool select commands
2. Drilling
3. 2-axis control

1. Manual or mechanical
2. Programmed

VI. POINT TO POINT PROGRAMMING (1.5 hours, lab)

1. Basic word address commands - review
    1. Sequence numbers
    2. Feedrate commands
    3. Spindle speed commands
    4. Miscellaneous functions
    5. Tool select commands
2. Drilling
3. 2-axis control
    1. Manual or mechanical
    2. Programmed

VII. COMPUTER AIDED NUMERICAL CONTROL PROGRAMMING (4 hours, lecture)

1. Text editor
2. Input and output
3. Screen plotting
4. Geometry creation
5. Simulator
6. Polar coordinate programming
7. Scaling, rotation, mirror and transformation

VIII. COMPUTER AIDED NUMERICAL CONTROL PROGRAMMING (3 hours, lab)

1. Text editor
2. Input and output
3. Screen plotting
4. Geometry creation
5. Simulator
6. Polar coordinate programming
7. Scaling, rotation, mirror and transformation

IX. MACHINE OPERATIONS (3 hours, lecture)

1. Program input
2. Fixture setup
3. Tool setting
4. Program editing
5. Control panels

X. MACHINE OPERATIONS (1.5 hours, lab)

1. Program input
2. Fixture setup
3. Tool setting
4. Program editing

5. Control panels

XI. EXTENDED WORD ADDRESS FORMAT PROGRAMMING RS 274C (6 hours, lecture)

1. Description
2. Program entries
    1. Tool length offsets
    2. Part and fixture offsets
    3. R planes
    4. Z-axis canned cycles
3. Canned mill cycles
4. Repetitive programming
    1. Loops
    2. Macros
    3. Subroutines
    4. Subprograms
5. Cutter diameter compensation
6. Metric programming

XII. EXTENDED WORD ADDRESS FORMAT PROGRAMMING EIA 274 (2.5 hours, lab)

1. Description
2. Program entries
    1. Tool length offsets
    2. Part and fixture offsets
    3. R planes
    4. Z-axis canned cycles
3. Special mill cycles
4. Repetitive programming
    1. Loops
    2. Macros
    3. Subroutines
    4. Subprograms
5. Cutter diameter compensation
6. Metric programming

XIII. THREE AXIS PROGRAMMING (8 hours, lecture)

1. Plane and slopes
2. Z-axis circular interpolation
3. Scallops and cusps
4. Keller
5. Spiral
6. Tooling and fixtures

7. Quick change tooling
8. Pre-set tooling
9. Automatic tool changer
10. Workholding methods

XIV. THREE AXIS PROGRAMMING (4 hours, lab)

1. Plane and slopes
2. Z-axis circular interpolation
3. Scallops and cusps
4. Keller
5. Spiral
6. Tooling and fixtures
7. Quick change tooling
8. Pre-set tooling
9. Automatic tool changer
10. Workholding methods

XV. CNC LATHE PROGRAMMING (7 hours, lecture)

1. Machine types
2. Lathe axes
3. Programming entries
    1. Tool commands
    2. Tool length offsets - tool tip and turret center
    3. Spindle speeds - direct and constant surface speed
    4. Diameter versus radius programming
    5. Absolute versus incremental
4. Facing operations
5. Turning operations - linear and circular interpolation
6. Arc center offsets (I, K and R)
7. Roughing cycles
8. Finish cycles

XVI. CNC LATHE PROGRAMMING (4 hours, lab)

1. Machine types
2. Lathe axes
3. Programming entries
    1. Tool commands
    2. Tool length offsets - tool tip and turret center
    3. Spindle speeds - direct and constant surface speed
    4. Feeds
    5. Diameter versus radius programming
    6. Absolute versus incremental
4. Facing operations
5. Turning operations - linear and circular interpolation
6. Arc center offsets (I, K and R)

6. Arc center offsets (I, K and R)
7. Roughing cycles
8. Finish cycles

XVII. BORING OPERATIONS (2 hours, lecture)

1. Drilling operations
2. Id rough cycle
3. Threading cycles

XVIII. BORING OPERATIONS (4 hours, lab)

1. Drilling operations
2. Cutter path problems
3. Threading cycles

Total Lecture Hours: 45

Total Laboratory Hours: 27

Total Hours: 72

IV. Primary Method of Evaluation and Sample Assignments

A. Primary Method of Evaluation (choose one):

1) Substantial writing assignments

2) Problem solving demonstrations (computational or non-computational)

3) Skills demonstrations

Primary Method of Evaluation: 3) Skills demonstration

B. Typical Assignment Using Primary Method of Evaluation

Typical Assignment Using Primary Method of Evaluation: Create a program model for a mechanical part to be manufactured on a CNC milling machine. Include the following: written job plan, written tool descriptions, machine tool manuscript and machine tool setup instructions. Submit CNC program and supporting documents that is a maximum of 50 pages electronically to the instructor.

C. College-level Critical Thinking Assignments

Critical Thinking Assignment 1: Given an engineering drawing, write a program for the CNC milling machine using the G and M codes including all tool lists and job process sheet that would produce the part within the tolerances specified. Submit a CNC program and supporting documents that is a maximum of

tolerances specified. Submit a CNC program and supporting documents that is a maximum of 50 pages electronically to the instructor.

Critical Thinking Assignment 2: Create a complete package that includes a fixture sketch, job plan, tool list, machine tool manuscript, sketch and machine tool setup instructions for a CNC machining center. Submit program and supporting documents that is a maximum of 100 pages electronically to the instructor.

D. Other Typical Assessment and Evaluation Methods

Examples: **Class Performance, Objective Exam, Clinical Evaluation, Oral Exams, Completion, Other Exams, Embedded Questions, Performance Exams, Essay Exams, Presentation, Fieldwork, Quizzes, Homework Problems, Reading Reports, Journal kept throughout course, Term or Other Papers, Laboratory Reports, True/False, Matching Items, Written Homework, Multiple Choice, Other (specify)**

Other Evaluation Methods:
Other exams
Quizzes
Class Performance
Homework Problems
Multiple Choice
Completion
Matching Items
True/False
Other (specify): Programming problems
Term Project

V. Instructional Methods

Examples: **Lecture, Group Activities, Lab, Role play/simulation, Discussion, Guest Speakers, Multimedia presentations, Field trips, Demonstration, Other (specify)**

Instructional Methods:
Demonstration
Laboratory
Lecture

If other:
CNC program assignments
CNC machine tool set-up

Note: In compliance with Board Policies 1600 and 3410, Title 5 California Code of Regulations, the Rehabilitation Act of 1973, and Sections 504 and 508 of the Americans with Disabilities Act, instruction delivery shall provide access, full inclusion, and effective communication for students with disabilities.

VI. Work Outside of Class

Work Outside of Class:* Study

Required reading

Problem solving activities

If Other: Programming Assignments

VII. Texts and Materials

A. Up-to-date Representative Textbooks: Please use the following format(s):

Printed Text - Author, Title, Edition, Publisher, Year.
Digital Text (OER Text) - Author (last name first). Title. Edition or Version (if beyond 1st). Publisher, Publication year or Revision date. URL. License.
***Sample:** Dillon, Dave. Blueprint for Success in College and Career. Version 1.3. Rebus Community, 2018. press.rebus.community/blueprint2/. Licensed under CC BY 4.0.*

If you wish to list a text that is more than 5 years old, please annotate it as a "discipline standard".

***Multiple textbooks may be listed.**

Up-To-Date Representative Textbooks: James Valentino. INTRODUCTION TO COMPUTER NUMERICAL CONTROL (CNC). 5th edition. Pearson, 2013. (Discipline Standard)

B. Alternative Textbooks: Please use the following format(s): if applicable

Printed Text - Author, Title, Edition, Publisher, Year.

Digital Text (OER Text) - Author (last name first). Title. Edition or Version (if beyond 1st). Publisher, Publication year or Revision date. URL. License.

***Sample:** Dillon, Dave. Blueprint for Success in College and Career. Version 1.3. Rebus Community, 2018. press.rebus.community/blueprint2/. Licensed under CC BY 4.0.*

If you wish to list a text that is more than 5 years old, please annotate it as a "discipline standard".

***Multiple textbooks may be listed.**

Alternative Textbooks:

C. Required Supplementary Readings

Required Supplementary Readings:

D. Other Required Materials

Other Required Materials: Removable memory media

Calculator

VIII. Conditions of Enrollment

A. Requisites (Course Prerequisites and Corequisites) Skills needed without which a student would be highly unlikely to succeed.

Requisite: Prerequisite

Category: sequential

Requisite course(s): List both prerequisites and corequisites in this box.

Machine Tool Technology-10A

Machine Tool Technology-40 AND

Machine Tool Technology-101 or

Machine Tool Technology-46

Requisite and Matching skill(s):Bold the requisite skill. List the corresponding course objective under each skill(s).

Write word address numerical control programs to perform point to point drilling and milling operations. Also be able to input, edit, print and plot a numerical control program on a microcomputer system.

MTT 10A - Write a word address CNC program to perform point to point drilling and milling operation that would produce projects or exercises within the tolerance specified on engineering drawings.

Calculate the speeds and feeds for the basic cutting tools used in the machine shop environment.

MTT 40 - Calculate the proper cutting speeds and feeds for lathes, milling machines and drilling machines.

MTT 101 - Solve shop math problems that involve speeds and feeds, threads, engineering drawing interpretation and calculations relating to machine tools.

Use trigonometric principles to solve right angle trigonometry problems.

MTT 40 - Using trigonometric principles, solve problems that include similar triangles, isosceles triangles, right triangles and polygons.

Have a working knowledge of the milling machine, lathe and their machining operations.

MTT 101 - Set up and operate engine lathes to turn, face, center drill, thread, and cut off to produce assigned work within the tolerances specified on engineering drawings.

MTT 101 - Set up and operate vertical and horizontal milling machines to square stock, mill flat surfaces, side mill, end mill, fly cut and slot to produce assigned work within the tolerances specified on engineering drawings.

MTT 46 - Set up and operate engine lathes to turn, face, center drill, thread, and cut off to produce projects within the tolerances on the engineering requirements.

MTT 46 - Set up and operate vertical and horizontal milling machines to square stock, mill flat surfaces, side mill, end mill, fly cut and slot to produce projects within the tolerances specified on the engineering requirements.

Read standard sketches and engineering drawings.

MTT 101 - Interpret orthographic projection engineering drawings that incorporate geometric dimensioning and tolerancing to produce assigned work within the tolerances specified on engineering drawings.

Knowledge of the basic types of cutting tools used in the machine shop environment.

MTT 101 - Select and use metal working hand tools to produce assigned work within the tolerances specified on engineering drawings.

MTT 46 - Select and use metal working hand tools to produce projects within the tolerances specified by engineering requirements.

specified by engineering requirements.

B. Requisite Skills: (Non-Course Prerequisite and Corequisites) Skills needed without which a student would be highly unlikely to succeed.

Requisite Skill: or equivalent experience

Requisite Skill and Matching Skill(s): Bold the requisite skill(s). If applicable If a student has taken Machine Tool Technology 10A, 40, 101 or 46 at another college, the student will be prepared to enroll in this course. If students have basic CAD/CAM skills, basic machining skills and machine calculation experience, they will be prepared to enroll in this course. It is important for students to have basic machining, CAD/CAM and machine shop calculation skills in order to succeed in this course.

C. Recommended Preparations (Course) (Skills with which a student's ability to succeed will be strongly enhanced.)

Requisite course:

Requisite and Matching skill(s):Bold the requisite skill. List the corresponding course objective under each skill(s).

D. Recommended Preparation (Non-Course) (Skills with which a student's ability to succeed will be strongly enhanced.)

Requisite Skill:

Requisite Skill and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s). If applicable

E. Enrollment Limitations

Enrollment Limitations and Category:

Enrollment Limitations Impact:

Course Created by: Jerry Kinnan **Date:** 09/01/1972

Original Board Approval Date:

Last Reviewed and/or Revised by: Victor Delatorre **Date:** 06/02/2022

Last Board Approval Date: 07/17/2023 effective FALL 2024