DE ANZA COLLEGE
APPLIED TECHNOLOGY DIVISION
COURSE OUTLINE

Degree Applicable

MANUFACTURING & CNC TECHNOLGY 75A Effective: Fall 2004

I. Catalog Information

MCNC 75A Introduction to Computer-Aided Numerical Control (CNC) Programming and Operation; Mills 4 1/2 Units

Advisory: Manufacturing & CNC 71 or experience in machining processes, EWRT 100A and Reading 201 (or ESL 161-163).

Nine hours lecture/lab.

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

II. Course Objectives

The student will:

A. Describe CNC milling machine types, applications and components.
B. Select and calculate logical mill cutter paths.
C. Prepare basic three-axis programs for milling machine operations.
D. Operate a mill CNC controller to download programs and run tool tryouts.
E. Describe mill setup procedures for securing workpieces.
F. Use travel and test indicators to inspect the accuracy of machined parts.
G. Describe Mill and Lathe Cutting Tool Materials; Characteristics, Shapes and Uses.
H. Explain the common types and characteristics of CNC milling machine tooling

III. Essential Student Materials

Scientific calculator (Texas Instruments-TI30 recommended)

IV. Essential College Facilities

Laboratory/classroom equipped with precision measuring tools, CNC machines, tooling, computers, peripherals and software.

V. Expanded Description: Content and Form

A. Introduction to computer numerical control
   1. CNC milling machine types and applications
   2. Numerical control components
      a. Computer
      b. Drive motor types
      c. Close loop systems
      d. Transducers
   3. Feed mechanism types
      a. Recirculating ball screws

b. Pneumatic and hydraulic
4. Data mediums
a. 1 inch tape and readers (historical reference)
b. Magnetic tape and floppy disk
c. Manual data input (MDI)
d. Direct numerical control (DNC)
5. Controller programming formats
a. Word address, EIA/ISO standardized alpha numeric codes
b. Conversational
6. Mill axis and machine interpretation
a. Cartesian coordinate system
(1) X,Y, Z, axis designations
(2) A,B, & 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. Cutter path logic 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
(1) Spring pass
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
(a) Computing unknown sides and angles
(b) Conversion of minutes/seconds to decimal degrees and vice versa
(c) Scientific calculator operation
2. Calculation of cutter compensation
(a) Definition of point, line, angle and arc
(b) Plot coordinate points for mill cutters
(1) To form inside/outside square obtuse and oblique corners
(2) To form inside/outside corners with 90° arcs

C. Basic 3-axis programming for mills
1. Manuscript preparation
a. Basic miscellaneous functions
b. Speed, feed and tool address
c. Tool coordinates
(1) Circular interpolation
(a) With I and J
(b) With R
(2) Slotting
(3) Plunge milling methods
(a) Pre-drill
(b) 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) Used with L repeat command
e. Tool length offset
f. Cutter compensation
(1) Ramp on/off moves
g. Incremental and absolute
(1) Switching mid program

D. Mill CNC controller
1. Down load programs from PC or DNC
2. Down load programs from floppy disk or tape
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. Mill setup procedures.
1. Workpiece/fixture alignment
2. Work clamping procedures for accuracy
3. Location and setting of workpiece/fixture zero

F. Precision inspection using indicators
1. Travel and test Indicators
a. Parts, attachments
b. Setups, cosine error
2. Gage blocks - classes, care, selecting blocks to build-up, wringing
3. Sine bar set-ups for angles
a. Calculate block build-up for angles
b. Calculate error of measured angle

G. Mill and lathe cutting tool materials; characteristics, shapes and uses
1. Carbide, Coatings
2. Ceramic
3. Diamond
4. Angles; relief and rake

H. 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
(a) Floating (tension/compression)
(b) Rigid
(4) Stub Arbors
(5) Adapters
(a) Morse
(b) Jacobs
(c) Boring head
2. Workholding
a. Vise and stop
b. Strap and toe clamps
c. Collet and V-blocks

VI. Assignments

A. Lab projects demonstrating mastery of skills.
B. Take home worksheets involving calculations

C. Reading from textbooks and references

VII. Methods of Evaluating Objectives

A. One midterm examination covering lecture material and lab demonstrations
B. Completion of take home worksheets
C. Completion of laboratory exercises
D. A comprehensive, objective final exam

VIII. Texts and Supporting References

A. Text:
   1. Michael Engle, CNC Programming Manual, De Anza College, Cupretino, CA.,2003.
B. References:
   1. Joseph Pusztai and Michael Sava, Computer Numerical Control. Reston, Virginia: Reston, 2002.