A. **TITLE:** Introduction to Computer Numerical Control

B. **COURSE NUMBER:** MECH 223

C. **CREDIT HOURS:** (3)

D. **WRITING INTENSIVE COURSE:** No

E. **COURSE LENGTH:** 15 weeks

F. **SEMESTER(S) OFFERED:** Fall or Spring

G. **HOURS OF LECTURE, LABORATORY, RECITATION, TUTORIAL, ACTIVITY:**
   - 2 lecture hours per week
   - 3 laboratory hours laboratory per week

H. **CATALOG DESCRIPTION:**
   A course designed to introduce students to the capabilities of CNC machine tools used in industry, to teach students the fundamentals in programming CNC lathes and milling machines, to provide students the opportunity to setup and operate CNC equipment and to experience the use of CAD/CAM technology.

I. **PRE-REQUISITES/CO-REQUISITES:** MECH 121

J. **GOALS (STUDENT LEARNING OUTCOMES):**
   By the completion of this course students will be able to:

<table>
<thead>
<tr>
<th>Course Objective</th>
<th>Institutional SLO</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Select the proper tooling used on CNC Milling Machines and Lathes.</td>
<td>2. Critical Thinking 3. Professional Competence</td>
</tr>
<tr>
<td>3. Write the proper process plan required for CNC operation.</td>
<td>1. Communication 2. Critical Thinking</td>
</tr>
<tr>
<td>4. Setup and operate 2 axis and 3 axis CNC Milling Machines (Centers) and 2 axis CNC Lathes.</td>
<td>2. Critical Thinking 3. Professional Competence</td>
</tr>
<tr>
<td>5. Enter a program into a CNC machine using the conversational programming format.</td>
<td>2. Critical Thinking 3. Professional Competence</td>
</tr>
<tr>
<td>6. Create CNC programs using CAD/CAM technology</td>
<td>3. Professional Competence</td>
</tr>
</tbody>
</table>
K. **TEXTS:** HAAS CNC programming workbook for Mill and Lathe

L. **REFERENCES:** Machinery’s Handbook, 26th edition, Industrial Press

M. **EQUIPMENT:** Machine Tools Lab

N. **GRADING METHOD:** A-F

O. **MEASUREMENT CRITERIA/METHODS:** Exams, Homework, Laboratory

P. **DETAILED COURSE OUTLINE:** See attached

Q. **LABORATORY OUTLINE:** See Attached
Detailed Outline

MECH 223 – Introduction to Computer Numerical Control

I. Introduction to Machine Tool Controls
   A. Components
      1. Machine Tools
      2. Machine Control Unit (MCU)
   B. Type of Control Systems
      1. Point to Point
      2. Continuous Path
   C. Loop Systems
      1. Open Loop vs. Closed Loop
   D. Positioning Systems
      1. Absolute vs. Incremental

II. Tooling for CNC
   A. General Tooling Considerations for CNC
   B. Types of Tooling Used
   C. Special Tools
   D. Cutting Speeds and Feed Rates
   E. Tool Changing

III. CNC Machining Center Features

IV. Programming Coordinates
   A. Hole Operations
   B. Milling Operations (Linear & Circular Profiling)
   C. Mixing Absolute and Incremental Coordinates
   D. Metric Coordinates

V. Three Axis Programming (Milling)
   A. Word Address Format
      1. Address codes
      2. Preparatory codes (G – codes)
      3. Miscellaneous codes (M – codes)
      4. Math for CNC Programming
   B. Modal Programs
      1. Drilling
      2. Milling

VI. Two Axis Programming (Lathe)
   A. Word Address Format
      1. How lathe codes differ from milling
      2. New codes
   B. Modal Programs
1. Turning
2. Radius cutting
3. Threading
C. Setting up and operation of HAAS Turning Center

VII. Do Loops and Subroutines
   A. Do Loops
   B. Subroutines
   C. Nested Loops
   D. Modal Programs

VIII. Advanced CNC Features
   A. Cutter Diameter Compensation (CDC)
   B. Fixture Offsets
   C. Tool Offsets (TLO)
      1. Measuring
      2. Calculating
      3. Input at MCU

X. CAD/CAM
   A. Part Definition
   B. Toolpath Generation
   C. Post Processing for various controllers

Laboratory Outline

MECH 223 – Introduction to Computer Numerical Control

I. CNC Vertical Mill
   A. Program Entry
   B. Tool Setting
   C. Work Offset Setting
   D. Verifying Program
   E. Editing Program
   F. 4th Axis Indexing

II. CNC Lathe
   A. Program Entry
   B. Tool Setting
   C. Work Offset Setting
   D. Verifying Program
   E. Editing Program
   F. Setting up a Turret
   G. Using Parts Catcher
III. CAD/CAM
   A. Geometry Design 2D/3D
   B. Tool path creation
   C. Post Processing
   D. Program verification