I. **OVERVIEW**  
The following information will appear in the 2012 - 2013 catalog

MACH 311  **CNC Programming with Macros**  1 Unit  

*Recommended for Success:* Before enrolling in this course, students are strongly advised to satisfactorily complete MACH-219 and have previous CNC programming experience or on-the-job training.

The application and practice of using macro techniques in the development of programs for the operation of CNC machine tools.

*Materials Fee Required*

Two maximum completions.  
Field trips might be required.  
(P/NP Only) Lecture /Lab

II. **LEARNING CONTEXT**  
Given the following learning context, the student who satisfactorily completes this course should be able to achieve the goals specified in Section III, Desired Learning:

A. **COURSE CONTENT**

1. **Required Content:**

a. **INTRODUCTION TO MACROS**

   i. What is a Macro Programming
   ii. Usage of Macros
   iii. Groups of Similar Parts
   iv. Offset Control
   v. Custom Fixed Cycles
   vi. Special G-codes and M-codes
   vii. Alarm and Message Generation
   viii. Probing and Gauging
   ix. Short cuts and Utilities

b. **BRIEF REVIEW OF PROGRAMMING TOOLS**

   i. G-codes and M-codes
   ii. Preparatory Commands
   iii. Miscellaneous Functions
   iv. Default Settings
   v. Modal Values
vi. Programming Format
vii. Rules of Subprograms
viii. Subprogram Nesting

c. SYSTEM PARAMETERS
   i. What are Parameters
   ii. Binary Numbers
   iii. Parameter Classification
   iv. Parameter Data Types
   v. Setting and Changing Parameters
   vi. Protection of Parameters
   vii. Changing Parameters
   viii. System Defaults

d. DATA SETTING
   i. Data Setting Commands
   ii. Coordinate Mode
   iii. Work Offsets
   iv. Memory Types - Milling and Turning
   v. Geometry Offset
   vi. Wear Offset
   vii. Adjusting Offsets
   viii. Absolute Mode
   ix. Incremental Modes
   x. Tool Offset Entry
   xi. MDI Data Setting
   xii. Programmable Parameter Entry
   xiii. Modal G10 Command
   xiv. Effect of Block Numbers

e. MACRO STRUCTURE
   i. Basic Tools
   ii. Variables
   iii. Functions and Constants
iv. Logical Operators

v. Defining and Calling Macros

vi. Macro Definition

vii. Macro Call

viii. Arguments

ix. Macro Program Numbers

f. CONCEPT OF VARIABLES

i. Types of Macro Variables

ii. Definition of Variables

iii. Variable Declaration

iv. Variable as an Expression

v. Usage of Variables

vi. Restrictions

vii. Custom Machine Features

g. ASSIGNING VARIABLES

i. Local Variables

ii. Assignment Lists

iii. Simple Macro Call

iv. Modal Macro Call

v. Main Program and Variables

vi. Local Variables and Nesting Levels

vii. Common Variables

viii. Volatile and Non-volatile Groups

ix. Input Range

x. Protecting Variables

h. MACRO FUNCTIONS

i. Function Groups

ii. Definition of Variables

iii. Referencing Variables

iv. Vacant Variables

v. Arithmetic Functions
vi. Division by Zero
vii. Trigonometric Functions
viii. Rounding Functions
ix. Miscellaneous Functions
x. Logical Functions
xi. Binary Numbers
xii. Conversion Functions
xiii. Evaluation of Functions

i. SYSTEM VARIABLES
   i. Identifying System Variables
   ii. System Variables Groups
   iii. Read Only Variables
   iv. Read and Write Variables
   v. Displaying System Variables
   vi. System Variables for Various Controls
   vii. Organization of System Variables
   viii. Resetting Program Zero

j. TOOL OFFSET VARIABLES
   i. System Variables and Tool Offsets
   ii. Tool Offset Memory Groups
   iii. Tool Offsets and the Number of Offsets
   iv. Tool Offsets and Control Types
   v. Tool Setting

k. MODAL DATA
   i. System Variables for Modal Commands
   ii. Preceding and Executing Blocks
   iii. Modal G-codes
   iv. Saving and Restoring Data
   v. Other Modal Codes

l. BRANCHING AND LOOPING
i. Decisions in Macro Development

ii. IF Function

iii. Conditional Branching

iv. Unconditional Branching

v. IF-THEN Option

vi. Single Conditional Expressions

vii. Combined Conditional Expressions

viii. Concept of Loops

ix. WHILE Loop Structure

x. Single Level Nesting Loop

xi. Double Level Loop

xii. Triple Level Loop

xiii. Other Conditions

xiv. Restriction of the WHILE Loop

xv. Conditional Expressions and Vacant Variables

xvi. Clearing 500+ Series of Variables

m. ALARMS AND TIMERS

i. Alarms in Macros

ii. Alarm Number

iii. Alarm Message

iv. Alarm Format

v. Embedding Alarm in a Macro

vi. Resetting Alarm

vii. Message Variable

viii. Timers in Macros

ix. Time Information

x. Timing an Event

n. AXIS POSITION DATA

i. Axis Position Terms

ii. Position Information

o. AUTOMATIC OPERATIONS
i. Controlling Automatic Operations

ii. Single Block Control

iii. M-S-T Functions Control

iv. Feedhold, Feedrate and Exact Check Control

v. Systems Settings

vi. Controlling Number of Machined Parts

p. SECOND COMPLETION

i. The practice and application of advanced techniques in the use of macros when developing of programs to operate CNC machine tools will be addressed when the student repeats this course.

ii. The increased exposure and use of macros when programming will increase the skill and proficiency levels that are expected in the workplace in an industry application.

iii. Skills or proficiencies are enhanced by supervised repetition and practice to obtain adequate proficiency levels.

2. Required Lab Content:

   The content learned in lecture is applied in the lab setting.

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v. Systems Settings

vi. Controlling Number of Machined Parts

B. ENROLLMENT RESTRICTIONS

1. Advisories

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C. HOURS AND UNITS

<table>
<thead>
<tr>
<th>INST METHOD</th>
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<tr>
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D. METHODS OF INSTRUCTION (TYPICAL)

Instructors of the course might conduct the course using the following method:

1. Lecture

2. Video tape

3. Lab demonstration.

E. ASSIGNMENTS (TYPICAL)

1. EVIDENCE OF APPROPRIATE WORKLOAD FOR COURSE UNITS

Time spent on coursework in addition to hours of instruction (lecture hours)

1. The student will be expected to weekly review the previous lecture to verify thorough understanding of the subject matter covered at that time.
2. Weekly assigned task will be completed before the next class meeting, with any programs written, edited, and graphically verified by simulation software.
3. Before each class meeting, the student will preview the topic to be covered and understand the relationship of the subject matter to the previous lessons.

2. EVIDENCE OF CRITICAL THINKING

Assignments require the appropriate level of critical thinking

Assignment Example: You will systematically analyze the existing program and the operational sequence to determine if this process could be improved upon by applying the macro programming techniques that have been covered during this class. If it is determined that a substantial improvement would result, then you will select the most efficient format, determine necessary variables, and rewrite that portion of the program using sound Macro programming techniques.

F. TEXTS AND OTHER READINGS (TYPICAL)
III. DESIRED LEARNING

A. COURSE GOAL
   As a result of satisfactory completion of this course, the student should be prepared to:

   make use of macros in the development of programs that will operate CNC machine tools.

B. STUDENT LEARNING GOALS
   Mastery of the following learning goals will enable the student to achieve the overall course goal.

   1. Required Learning Goals
      Upon satisfactory completion of this course, the student will be able to:

      a. Recognize the need for a 'Macro Program' from a variety of machined part blueprints and quantify the benefit of using macros.

      b. Recognize the need for a macro program to control CNC machine functions, like work offsets, height offsets, diameter offsets, part counting, and others.

      c. Utilize the 'Fanuc Macro B' type language when preparing macro part programs.

      d. Read & interpret sample macros and describe the function of the macro to others.

      e. Check/set the CNC Machine parameters so macro programs can be executed.

      f. Understand how 'Macro Programs' can communicate with other CNC Machine Tool options, like probes & RS-232 serial communication input/output.

      g. Be able to troubleshoot & correct a macro program that is not working correctly.

      h. Understand & use variables for part feature dimensions.

      i. Realize the similarities of the 'Fanuc Macro B' language to the 'Basic' computer language.

   2. Lab Learning Goals
      Upon satisfactory completion of the lab portion of this course, the student will be able to:

      a. Write a program using Macro programming techniques that will produce the desired results when run on a Haas CNC simulator.

      b. in the second completion apply advanced techniques using macros to develop programs faster and more reliably to meet skill levels expected in the workplace.

IV. METHODS OF ASSESSMENT (TYPICAL)

A. FORMATIVE ASSESSMENT

   1. Instructor observation of student planning and development of programs during labs

   2. Review of project product quality to specifications

   3. Periodic short quizzes that evaluate understanding of material as it is introduced
B. **SUMMATIVE ASSESSMENT**

1. Final Exam

2. Evaluation of quality and accuracy of comprehensive final CNC programming project