

SMMG3040 - The introduction to Computer Numerical Control Machining

(Pengcheng HU, Aug. 2025)

Course description

This course provides a comprehensive exploration of Computer Numerical Control (CNC) manufacturing principles and applications, covering everything from the fundamentals of numerical control technology to the latest advancements in modern machine tool controls. Students will learn about CNC programming, lathe operations, drilling and milling processes, as well as multi-axis machining technologies. The course also introduces Electrical Discharge Machining (EDM) and Computer-Aided Programming (CAD/CAM), equipping students with a thorough understanding of the entire CNC manufacturing process, thereby laying a solid foundation for future career development.

Syllabus

Chapter 1: Introduction to Computer Numerical Control Manufacturing (3 classes)

Contents: (1) Numerical control definition, concepts and advantages; (2) Definition of computer numerical control and its components; (3) Advantages of CNC compared with NC; (4) CNC machining centers and turning centers; and (6) Other types of CNC equipment.

Chapter 2: Modern Machine Tool Controls (3 classes)

Contents: (1) Different types of system control; (2) Loop systems for controlling tool movement; (3) Cartesian coordinate systems; (4) CNC machine axes of motion; (5) Types of tool positioning modes; (6) Current advances in modern machine tool controls.

Chapter 3: Tooling for Hole and Milling Operations (3 classes)

Contents: (1) Tooling for drilling operations; (2) Carbide insert technology; (3) Tooling for hole operations that follow drilling; (4) Cutting speeds and feeds; (5) Tooling for profile milling and facing operations; (6) Feed directions for milling operations; (7) Cutting fluids for CNC operations.

Chapter 4: Features of CNC machining Centers (3 classes)

Contents: (1) Background on CNC machining centers; (2) Tooling systems used with automatic tool changers; (3) Methods of securing tools in tool holders; (4) Methods of securing tooling systems to the CNC spindle; (5) Automatic tool changer systems; (6) Pallet loading systems; (7) Features of the machine control unit (MCU)—machining centers.

Chapter 5: Programming of CNC machining (6 classes)

Contents: (1) Word address programming; (2) Programming hole operations; (3) Programming linear profile; (4) Programming circular profiles; (5) Programming with cutter diameter compensation; (6) Programming with subprograms.

Chapter 6: Interpolation (6 classes)

Contents: (1) Software interpolation; (2) Fine interpolation; (3) NURBS interpolation

Chapter 7: Acceleration and deceleration (6 classes)

Contents: (1) Acc/Dec Control After Interpolation; (2) Acc/Dec Control Before

Interpolation; (3) Look Ahead.

Chapter 8: Multi-axis CNC machining technology (4 classes)

Contents: (1) Five-axis machine centers; (2) Programming of five-axis machining; (3) Post-processor of five-axis machining.

Chapter 9: Typical Machine Tools and Their Future Development (4 classes)

Contents: (1) Typical machine tools; (2) The future of CNC machining.

Lab: Generation of G-code and CNC machining (4 classes)

Contents: (1) Introduction to hyperMILL software; (2) Generate planar tool path in hyperMILL; (3) Generate 3-axis tool path in hyperMILL; (4) Generate 5-axis tool path in hyperMILL; (5) Simulate tool path in Vericut.

Course Learning Outcomes

Upon completing this course, student will

- Be able to explain the fundamental concepts of Computer Numerical Control (CNC) manufacturing.
- Demonstrate proficiency in various CNC programming techniques.
- Be able to identify and apply appropriate tooling and machining operations for various CNC processes.
- Evaluate and analyze modern advancements in machine tool controls and CAD/CAM technologies, understanding their impact on CNC manufacturing efficiency and precision.

In the 2025 fall semester, there will be 38 hrs ordinary lecture hours and 4 additional lab hours.