



# STARK STATE COLLEGE

## GENERAL SYLLABUS

### Course Information

**Course Name:** Advanced CNC Operations  
**Course Number:** ARL222

### Required Materials

**Textbook(s):** Advanced CNC Operations Handbook Ariel Corp.  
**Required Readings:** None  
**Additional Materials:** Scientific Calculator, Laptops, Note Pads, Writing Utensils, Web Links, Handouts and related items as provided in class.

### Course Outline/Calendar

The date of coverage and order of coverage may be modified based on the faculty member and events beyond the control of faculty members that interfere with class times and teaching.

Week	Chapter/Topic/Lab
1 – Advanced CAD Modeling	<ul style="list-style-type: none"> <li>○ Review of geometric modeling and surfacing.</li> <li>○ Creating complex part geometries for 3- and 5-axis applications.</li> <li>○ Preparing CAD models for CAM software and validating part geometry.</li> </ul>
2 – Advanced CAM Toolpath Strategies	<ul style="list-style-type: none"> <li>○ Programming strategies for complex milling (roughing, finishing, high-speed machining).</li> <li>○ Introduction to advanced toolpath types, such as adaptive clearing and rest machining.</li> </ul>
3 – Multi-Axis CAM Programming	<ul style="list-style-type: none"> <li>○ Fundamentals of 4-axis and 5-axis programming.</li> <li>○ Utilizing rotary axis functionality for machining complex contours.</li> <li>○ Simulating toolpaths to detect and avoid collisions.</li> </ul>
4 – Post-Processing and Simulation	<ul style="list-style-type: none"> <li>○ Generating machine-specific G-code from CAM software.</li> <li>○ Testing programs in a virtual environment to confirm accuracy and efficiency.</li> <li>○ Understanding and editing post-processor settings for unique machine controls.</li> </ul>
5 – Advanced Workholding and Fixturing	<ul style="list-style-type: none"> <li>○ Designing and implementing custom fixturing solutions.</li> <li>○ Using multi-vice and modular clamping systems for maximum efficiency.</li> <li>○ Principles of fixture offsets and setting up multiple work origins.</li> </ul>
6 – Advanced Tooling and Tool Management	<ul style="list-style-type: none"> <li>○ Selection and application of specialized cutters, inserts, and tool holders.</li> <li>○ Configuring and managing a large tool library in CAM and on the machine control.</li> <li>○ Advanced concepts in tool length compensation and cutter diameter compensation.</li> </ul>
7 – 4-Axis and 5-Axis Setup and Operation	<ul style="list-style-type: none"> <li>○ Hands-on lab work setting up and operating multi-axis machines.</li> <li>○ Executing complex programs with rotational and simultaneous movements.</li> <li>○ Troubleshooting machine alarms and program errors.</li> </ul>

Week	Chapter/Topic/Lab
8 – Complex CNC Turning and Lathe Operations	<ul style="list-style-type: none"> <li>○ Advanced turning operations, including threading, tapping, and complex radius cutting.</li> <li>○ Setting up and running parts on multi-function turning centers (live tooling).</li> </ul>
9 – Advanced Speeds and Feeds	<ul style="list-style-type: none"> <li>○ Deep dive into optimizing cutting parameters for difficult materials (e.g., stainless steel, titanium).</li> <li>○ Balancing material removal rate with tool life and surface finish.</li> </ul>
10 – Process Planning and Lean Manufacturing	<ul style="list-style-type: none"> <li>○ Advanced job planning, process sheet creation, and setup reduction techniques.</li> <li>○ Applying lean manufacturing principles, such as 5S, to the machining environment.</li> </ul>
11 – Quality Control and Statistical Process Control (SPC)	<ul style="list-style-type: none"> <li>○ Interpreting complex Geometric Dimensioning and Tolerancing (GD&amp;T).</li> <li>○ Using advanced measurement tools (probes, CMMs) to ensure part quality.</li> <li>○ Using Statistical Process Control (SPC) to monitor and maintain process stability.</li> </ul>
12 – Introduction to Machine Automation	<ul style="list-style-type: none"> <li>○ Exploring automated part loading/unloading (robotics).</li> <li>○ Understanding the benefits and challenges of automated production cells.</li> <li>○ Hands-on practice with automated setups.</li> </ul>
13 – Alternative Machining Technologies	<ul style="list-style-type: none"> <li>○ Introduction to Electrical Discharge Machining (EDM) for intricate features.</li> <li>○ Overview of laser and waterjet cutting technologies.</li> </ul>
14 – In-Process Probing and Macro Programming	<ul style="list-style-type: none"> <li>○ Automating tool and part measurements using in-process probing routines.</li> <li>○ Learning basic macro programming to customize and automate machine cycles.</li> </ul>
15 – Final Project – CAM and Programming	<ul style="list-style-type: none"> <li>○ Students design and program a complex, multi-axis component using CAM software.</li> <li>○ Each program must include advanced toolpath strategies and optimized parameters.</li> </ul>
16 – Final Project – Setup, Machining, and Inspection	<ul style="list-style-type: none"> <li>○ Students independently set up and operate the CNC machine to manufacture their final project part.</li> </ul>