



FIT4FUTURE

CNC Machining for everybody

Curriculum

Multi-Sided CNC Machining

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1. COURSE TITLE: MULTI-SIDED CNC MACHINING

1.1. INSTRUCTOR: N.N.

1.2. COURSE DURATION: 16 WEEKS

1.3. COURSE DESCRIPTION

This course introduces students to the fundamentals of multi-sided CNC machining, including setup, programming and operation of CNC machines for machining complex geometries from multiple sides. Emphasis is placed on developing practical skills, safety procedures and understanding CNC machining principles.

1.4 DESCRIPTION OF LEARNING OUTCOMES:

1.4.1 AFTER SUCCESSFULLY COMPLETING THIS COURSE, PARTICIPANTS WILL BE ABLE TO

1. Understand the principles of multi-sided CNC machining.
2. Interpret technical drawings and develop machining strategies for multi-sided parts.
3. Demonstrate knowledge of setting up and operating CNC machines for multi-sided machining.
4. Apply appropriate tool, fixture and cutting parameters for multi-sided CNC operations.
5. Solve common problems that occur during multi-sided CNC machining.
6. Develop and modify CNC programs for multi-sided machining with CAM software.
7. Adhere to safety protocols and best practices in a CNC machining environment.

1.4.2 THESE LEARNING OUTCOMES WERE DESIGNED WITH DIFFERENT LEVELS

1. **Understand the principles of multi-sided CNC machining.**
 - Level 1: Describe the basic principles of multi-sided CNC machining.
 - Level 2: Explain advanced concepts and techniques in multi-sided CNC machining.
 - Level 3: Analyze complex multi-page processing scenarios and propose optimized solutions.

2. Interpret technical drawings and develop machining strategies for multi-sided parts.

- Level 1: Interpreting basic technical drawings for multi-page parts.
- Level 2: Develop machining strategies based on moderately complex technical drawings.
- Level 3: Interpret complicated technical drawings accurately and develop optimized machining strategies.

3. Demonstrate knowledge of setting up and operating CNC machines for multi-sided machining.

- Level 1: Carry out basic set-up and operational tasks under supervision.
- Level 2: Independent set-up and operation of CNC machines for medium-complex multi-sided machining tasks.
- Level 3: Demonstrate proficiency in setting up and operating CNC machines for highly complex multi-sided machining tasks.

4. Apply appropriate tool, fixture and cutting parameters for multi-sided CNC operations.

- Stage 1: Identify basic tool, fixture and cutting parameters for multi-sided machining.
- Stage 2: Selection and application of suitable tool, fixture and cutting parameters for moderately complex multi-sided machining tasks.
- Stage 3: Optimization of tool, fixture and cutting parameters for demanding multi-sided machining processes.

5. Solve common problems that occur during multi-sided CNC machining.

- Stage 1: Recognize and identify common processing problems.
- Level 2: Diagnosing and solving moderately complex machining problems.
- Level 3: Analyze and solve complicated machining problems efficiently.

6. Develop and modify CNC programs for multi-sided machining with CAM software.

- Level 1: Create basic CNC programs with CAM software.



- Level 2: Modify existing CNC programs for moderately complex multi-sided machining tasks.
- Level 3: Develop advanced CNC programs and optimize toolpaths for complicated multi-sided machining operations.

7. Adhere to safety protocols and best practices in a CNC machining environment.

- Level 1: Follow basic safety protocols in a CNC machining environment.
- Level 2: Implement comprehensive security measures and best practices for multi-page editing processes.
- Level 3: Implement safety initiatives and ensure compliance with the highest safety standards in CNC machining environments.

1.5 COURSE OVERVIEW:

UNIT 1: INTRODUCTION TO MULTI-SIDED CNC MACHINING

Learning Outcomes: Understand the concept and importance of multi-sided CNC machining.

Topics:

- Overview of the principles of CNC machining
- Introduction to multi-page editing
- Applications and advantages of multi-sided CNC machining
- Activities/Assessments:
- Class discussion on practical examples for multi-page editing applications
- Quiz on the basics of CNC machining

UNIT 2: READING TECHNICAL DRAWINGS FOR MULTI-PAGE PROCESSING

Learning Outcomes: Develop the ability to interpret technical drawings for multi-page parts.

Topics:

- Understanding geometric dimensioning and tolerances (GD&T)
- Reading multi-view drawings and isometric views
- Identification features for multi-sided processing
- Activities/Assessments:
- Group exercises on the interpretation of technical drawings
- Interpretation assignments for drawings

UNIT 3: SET-UP AND PREPARATION FOR MULTI-SIDED PROCESSING

Learning Outcomes: Acquire skills in setting up CNC machines for multi-sided operations.

Topics:

- Selection and setup of workpiece holders
- Tool selection and setup
- Workpiece alignment and referencing
- Activities/Assessments:
- Practical exercises for setting up CNC machines
- Written assessments on fixture settings and alignment techniques

UNIT 4: PROGRAMMING FOR MULTI-SIDED MACHINING

Learning Outcomes: Develop skills in programming CNC machines for multi-sided operations.

Topics:

- Introduction to Computer-Aided Manufacturing (CAM) software
- Programming strategies for multi-page processing
- Toolpath generation and optimization
- Activities/Assessments:
- CAM software tutorials and exercises
- Programming tasks for multi-page parts

UNIT 5: OPERATION AND TROUBLESHOOTING FOR MULTI-PAGE PROCESSING

Learning Outcomes: Acquire the ability to effectively operate CNC machines and troubleshoot common problems.

Topics:

- Safe operation of CNC machines
- Monitoring machine performance during processing
- Identifying and solving common machining problems
- Activities/Assessments:
- Simulation exercises for operating CNC machines
- Troubleshooting scenarios and role-playing activities

UNIT 6: ADVANCED TECHNIQUES IN MULTI-PAGE EDITING

Learning Outcomes: Discover advanced techniques and strategies for complex multi-page editing.

Topics:

- Basics of 5-axis machining
- Indexing and rotary table operations
- Adaptive processing strategies
- Activities/Assessments:
- Case studies on complex multi-page editing projects
- Practical demonstrations of advanced processing techniques

UNIT 7: SAFETY AND BEST PRACTICES

Learning Outcomes: Understand and follow safety protocols and best practices in a CNC machining environment.

Topics:

- Requirements for personal protective equipment (PPE)
- Machine-specific safety procedures
- Hazard identification and mitigation
- Activities/Assessments:
- Safety tests and assessments
- Practical demonstration of security procedures

1.6 COURSE MATERIALS:

- Textbook
- Online course - e-learning and videos
- CAM software
- Technical drawings: Will be provided by the instructor
- Safety equipment: Provided by the institution

1.7 ASSESSMENT OF LEARNING OUTCOMES

Various assessment methods and didactic approaches can be used to effectively assess and deliver the specified learning outcomes. Below you will find some suggestions for each learning outcome:

1.7.2 UNDERSTAND THE PRINCIPLES OF MULTI-SIDED CNC MACHINING

- **Level 1 (Describe the basic principles):**
 - Assessment method: Written quizzes or short answer tests that focus on basic concepts such as types of multi-sided machining, axis configurations, and basic toolpath strategies.
 - Didactics: Lectures, presentations and multimedia resources to introduce and explain basic concepts. Practical demonstrations with physical models or simulations can improve understanding.
- **Level 2 (Explain advanced concepts and techniques):**
 - Assessment method: Case studies or problem-solving exercises that require students to apply advanced techniques such as 5-axis machining or simultaneous toolpath optimization.
 - Didactics: In-depth lectures and discussions on advanced topics, supplemented by practical examples and guest speakers from industry. Practical exercises with CAM software and CNC simulation tools to demonstrate advanced concepts.
- **Level 3 (Analyze complex scenarios and propose optimized solutions):**
 - Assessment method: research projects or project-based assessments in which students analyze complex multi-page editing scenarios and propose optimized editing strategies.
 - Didactics: Collaborative learning activities, group discussions and guided projects that challenge students to think critically and apply their knowledge to solve complex problems. Real-world case studies and site visits to observe advanced multi-sided editing processes in action.

1.7.3 INTERPRET TECHNICAL DRAWINGS AND DEVELOP MACHINING STRATEGIES FOR MULTI-SIDED PARTS

- **Level 1 (interpreting basic drawings):**
 - Assessment method: drawing interpretation exercises where students identify basic features and dimensions relevant to multi-sided machining.
 - Didactics: Step-by-step tutorials on how to read technical drawings, supplemented by practical exercises with simplified drawings. Peer review sessions to reinforce learning and provide feedback.
- **Level 2 (development of processing strategies based on moderately complex drawings):**
 - Assessment method: Design projects or tasks that require students to develop machining strategies based on moderately complex technical drawings.
 - Didactics: Interactive workshops combining theory and practice in which students analyze drawings, identify machining challenges and propose solutions. Instructor-led demonstrations of CAD/CAM software tools to develop machining strategies.
- **Level 3 (interpreting complicated drawings and developing optimized strategies):**
 - Assessment method: Final projects or simulations in which students accurately interpret complicated drawings and develop optimized machining strategies.
 - Didactics: In-depth seminars or workshops on the interpretation of GD&T symbols and complex geometric features. Practical projects or internships in cooperation with industry partners to work on real technical drawings and optimize machining processes.

These approaches integrate different assessment methods and didactic strategies to ensure comprehensive learning and skills development across different levels of competence. Adaptations can be made based on the specific needs and resources available in the educational environment.

1.8 DESCRIPTION OF THE ASSESSMENT CRITERIA FOR THE COURSE

1.8.1 EVALUATION CRITERIA:

UNDERSTAND THE PRINCIPLES OF MULTI-SIDED CNC MACHINING:

- **Level 1 (Describe the basic principles):**
 - Evaluation criteria:
 - Accuracy in identifying types of multi-sided machining, axis configurations and basic toolpath strategies.
 - Clarity and coherence in the explanation of basic concepts.
 - Proof of basic knowledge through written answers.
 - Weighting:
 - Written quizzes or tests: 40%
 - Participation and commitment in class: 20%
 - Practical demonstrations: 40%
- **Level 2 (Explain advanced concepts and techniques):**
 - Evaluation criteria:
 - Application of advanced techniques such as 5-axis machining or simultaneous toolpath optimization in case studies or problem-solving exercises.
 - Quality of explanations and justifications for chosen approaches.
 - Demonstrate critical thinking and problem solving skills.
 - Weighting:
 - Case studies or problem-solving exercises: 50%
 - Participation in discussions and presentations: 20%
 - Practical exercises with CAM software: 30%

- **Level 3 (Analyze complex scenarios and propose optimized solutions):**
 - Evaluation criteria:
 - Ability to analyze complex multi-sided processing scenarios and propose optimized processing strategies.
 - Depth of research and analysis in research projects or project-based assessments.
 - Creativity and innovation when proposing solutions.
 - Weighting:
 - Research projects or project-based assessments: 60%
 - Participation in joint activities and group discussions: 20%
 - Quality of presentations or reports: 20%

INTERPRET TECHNICAL DRAWINGS AND DEVELOP MACHINING STRATEGIES FOR MULTI-SIDED PARTS:

- **Level 1 (interpreting basic drawings):**
 - Evaluation criteria:
 - Accuracy in the interpretation of basic features and dimensions relevant to multi-sided machining.
 - Knowledge of identifying key elements in technical drawings.
 - Effectiveness in communicating interpretations.
 - Weighting:
 - Exercises for interpreting the drawing: 50%
 - Peer review meetings: 20%
 - Participation in tutorials and exercises: 30%
- **Level 2 (development of processing strategies based on moderately complex drawings):**

- Evaluation criteria:
 - Ability to develop machining strategies based on moderately complex technical drawings.
 - Quality and feasibility of the proposed strategies.
 - Understanding of CAD/CAM software tools demonstrated in practical exercises.
- Weighting:
 - Design projects or commissions: 60%
 - Participation in interactive workshops: 20%
 - Lecturer-led demonstrations: 20 %
- **Level 3 (interpreting complicated drawings and developing optimized strategies):**
 - Evaluation criteria:
 - Accuracy in the interpretation of complicated technical drawings.
 - Development of optimized machining strategies based on complex drawings.
 - Effectiveness in the implementation of strategies in final projects or simulations.
 - Weighting:
 - Capstone projects or simulations: 70%
 - Participation in advanced seminars or workshops: 20%
 - Quality of presentations or reports: 10%

GENERAL ASSESSMENT CRITERIA FOR THE MULTI-PAGE CNC COURSE:

- Participation in lessons, videos: 35%
- Tasks and quizzes: 65%

The curriculum is intended for trainers who can use the suggestions from the "generic" curriculum and the attached assessment grid (p 17 - p 23) and draw on their individual, case-specific USE CASES and incorporate these differentiated requirements as questions for theory and practice and use them with individual interfaces (digital, paper form, exercise on workpiece) for their "**blended learning sessions**".

The National Qualifications Framework (NQF) for education is a system for classifying and structuring educational qualifications within a country. It aims to promote transparency, comparability and recognition of qualifications.

The **NQF reference** is important **for the companies**, e.g. the apprenticeship training versus apprenticeship with Matura is something else, regarding the level as a professional higher qualification of master craftsmen through a Professional Bachelor (BA Pr), whereby this need - which qualification is desired by the level - can also **only be determined by the company**; our curriculum comprises a very general framework with the 3 levels (basic, advanced, professional). The training on the learning platform (videos and APPs) enables a basic perception of your skills and knowledge, both for new entry, further qualification or retraining. However, your previous knowledge of mathematics and technical engineering always forms the basis.



2. EVALUATION GRID FOR MULTI-SIDED CNC MACHINING

Learning outcome	Evaluation procedure
1) Understand the principles of multi-sided CNC machining	
Level 1: Describe the basic principles	- Written quizzes or tests with short answers
	- Participation and commitment in class
	- Practical demonstrations
Level 2: Explain advanced concepts and techniques	- Case studies or problem-solving exercises
	- Participation in discussions and presentations
	- Practical exercises with CAM software
Level 3: Analyze complex scenarios and propose optimized solutions	- Research projects or project-based assessments
	- Participation in collaborative activities and group discussions
	- Quality of presentations or reports
2) Interpret technical drawings and develop machining strategies for multi-sided parts	
Level 1: Interpreting basic drawings	- Exercises for interpreting the drawing
	- Peer review meetings
	- Participation in tutorials and exercises

Learning outcome	Evaluation procedure
Stage 2: Development of processing strategies based on moderately complex drawings	- Design projects or orders
	- Participation in interactive workshops
	- Demonstrations led by course instructors
Level 3: Interpret complicated drawings and develop optimized strategies	- Capstone projects or simulations
	- Participation in advanced seminars or workshops
	- Quality of presentations or reports
3) Proof of knowledge in setting up and operating CNC machines for multi-sided machining	
Level 1: Carry out basic set-up and operational tasks under supervision	- Observation assessments during installation and operation
	- Written or oral quizzes on set-up procedures
	- Completion of supervised facility tasks
Level 2: Independent set-up and operation of CNC machines for medium-complex tasks	- Practical reviews on setup and operation
	- Independent completion of set-up and processing tasks
	- Evaluation of setup and processing quality

Learning outcome	Evaluation procedure
Level 3: Demonstrate mastery of setting up and operating CNC machines for highly complex tasks	- Performance evaluations for complex setups and operations
	- Independent completion of complex set-up and processing tasks
	- Evaluation of precision, accuracy and efficiency in operation
4) Apply appropriate tool, fixture and cutting parameters for multi-sided CNC operations	
Stage 1: Identify basic tool, fixture and cutting parameters	- Identification tests for tools, devices and parameters
	- Observation of tool and fixture selection
	- Written reports on basic cutting parameters
Stage 2: Selection and application of suitable tool, fixture and cutting parameters for moderately complex tasks	- Practical evaluations of tools, devices and parameters
	- Evaluation of tool and fixture selection
	- Assessment of cutting parameter selection and application
Stage 3: Optimization of tool, fixture and cutting parameters for demanding processes	- Analysis of tools, devices and parameters in complex setups
	- Implementation of optimized tools, devices and parameters
	- Evaluation of efficiency and effectiveness in processing

Learning outcome	Evaluation procedure
5) Solve common problems that occur during multi-sided CNC machining	
Stage 1: Recognizing and identifying common processing problems	- Identification quiz on common processing problems
	- Observation of troubleshooting in practical sessions
	- Written or oral evaluations of solution approaches
Level 2: Diagnosing and resolving moderately complex problems	- Practical assessments for diagnosis and troubleshooting
	- Evaluation of troubleshooting strategies and solutions
	- Performance in solving moderately complex problems
Level 3: Efficiently analyze and solve complex machining problems	- Analysis of complicated processing problems during the projects
	- Implementation of effective solutions for complicated problems
	- Assessment of problem-solving competence and efficiency
6) Development and modification of CNC programs for multi-sided machining using CAM software	
Level 1: Create basic CNC programs with CAM software	- Creation of CNC basic programs with CAM software
	- Evaluation of program accuracy and functionality
	- Written or practical quizzes on CAM software functions
Level 2: Modifying existing CNC programs for moderately complex tasks	- Modification of existing CNC programs for specific tasks

Learning outcome	Evaluation procedure
	- Evaluation of program changes and functionality
	- Completion of tasks with modified CNC programs
Level 3: Develop advanced CNC programs and optimize toolpaths	- Development of advanced CNC programs and optimized toolpaths
	- Evaluation of program complexity and optimization
	- Implementation of optimized tool paths in machining
7) Compliance with safety protocols and best practices in a CNC machining environment	
Step 1: Follow basic safety protocols	- Compliance with basic safety protocols
	- Written assessments of safety procedures and practices
	- Completing security checklists or quizzes
Stage 2: Implement comprehensive safety measures for multi-page processing	- Evaluation of security practices during setup and editing
	- Participation in safety talks and workshops
	- Carrying out safety assessments or audits
Level 3: Implement safety initiatives and ensure compliance with the highest safety standards in CNC machining environments.	- Development and implementation of security initiatives
	- Leadership role in the promotion and enforcement of safety standards

Learning outcome	Evaluation procedure
	- Assessment of safety culture and practices in the environment

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