Manufacturing Technologies CTAG Alignment

This document contains information about a Career-Technical Articulation Number (CTAN) for the Manufacturing Technologies Career-Technical Assurance Guide (CTAG). The CTAN is:

1.) Computer Aided Drafting and Design: CTAN alignment with the ODE Engineering and Manufacturing Technologies Pathway in the Career Field Technical Content Standards.

Semester Credit Hours: 3

Course Description: This course prepares individuals to apply technical skills and advanced computer software and hardware to the creation of graphic representation and simulations in support of engineering projects. Includes instruction in engineering graphics, two-dimensional computer-aided drafting (CAD), computer-aided design (CADD), and Auto-CAD techniques.

Advising Notes:
Suggested Prerequisites: Engineering Drawing or Engineering Graphics.
The prerequisite shall be waived if the course (content) appears to address these concepts within the course content. Outcome #8 shall be viewed as an introduction to 3D. As long as 3D concepts are introduced in the course content this outcome is considered met.

Learning Outcomes with an asterisk are essential and must be taught.

Learning Outcomes **The student will be able to:**	**Outcomes and/or Competencies in ODE's REVISED Career Field Technical Content Standards**	
1.) Demonstrate proficiency of a commercial CAD system based on ASME (ANSI) Y 14.5 or equivalent ISO standards.*	1.4.4	Use system hardware to support software applications.
	5.3.2.	Evaluate a sketch and generate a model utilizing three-dimensional modeling software and techniques.
	5.3.3.	Compare conceptual, physical, and mathematical design models used to check proper design.
	5.3.4.	Perform part manipulation during the creation of an assembly model.
	5.3.5.	Analyze assembly constraints to successfully construct a multipart object.
	5.3.6.	Use part libraries effectively during the assembly modeling process.
	5.3.7.	Employ subassemblies during the production of assemblies.
	5.3.8.	Verify drive constraints that simulate the motion of parts in assemblies.
	5.3.10.	Translate a three-dimensional drawing or model into corresponding orthographic drawing views.

	5.3.13.	Create and interpret auxiliary views, orthographic projections, isometric drawings, oblique drawings, and perspective drawings.
	5.3.14.	Create a sectional view drawing.
	5.3.15.	Illustrate the types of breaks and symbols used in drawing sectional views.
	5.3.16.	Produce a reverse-engineered drawing from a solid object.
	5.3.17.	Add technical elements (e.g., parts lists, titles, finishes, tolerances, specifications, hidden surfaces) to drawings.
	6.1.3.	Identify measuring systems and convert between systems.
2.) Create working drawings using orthographic projections, section views, and auxiliary views.*	5.2.1.	Compare technical sketching and drawing.
	5.2.2.	Sketch possible solutions to an existing design problem.
	5.2.5	Create sketches using integration sketching techniques and styles.
	5.2.7.	Sketch geometric forms and shapes.
	5.2.9.	Select a view to graphically communicate a design solution.
	5.3.9.	Apply adaptive design concepts during the development of sketches, features, parts, and assemblies.
	5.3.13.	Create and interpret auxiliary views, orthographic projections, isometric drawings, oblique drawings, and perspective drawings.
	5.3.16.	Produce a reverse-engineered drawing from a solid object.

3.) Create detail drawings that include dimensions and tolerances.*	5.2.3.	Use tolerancing techniques when dimensioning.
	5.2.4.	Apply annotations on sketches and drawings.
	5.2.6.	Apply coordinate systems (e.g., absolute, relative, user, cylindrical, Cartesian).
	5.3.17.	Add technical illustrations (e.g., parts lists, titles, finishes, tolerances, specifications, hidden surfaces) to drawings.
	6.1.2.	Identify typical measurements in precision machining (e.g., angles, diameter, dimensions, and hardness).
	6.1.3.	Identify measuring systems and convert between systems.
	6.1.4.	Identify information and symbols typically provided in drawings and specifications.
	6.2.1.	Determine product requirements, dimensions, and tolerances from drawing and specifications.
4.) Utilize and apply the principles of sections to draw sectional views.*	5.3.14.	Create a sectional view drawing.
	5.3.15.	Illustrate the types of breaks and symbols used in drawing sectional views.
	6.1.4.	Identify information and symbols typically provided in drawings and specifications.
5.) Understand the principles of primary auxiliary views.*	5.3.13.	Create auxiliary views, orthographic projections, isometric drawings, oblique drawings, and perspective drawings.
	5.3.17.	Add technical illustrations (e.g., parts lists, titles, finishes, tolerances, specifications, hidden surfaces) to drawings.
	6.1.4.	Identify information and symbols typically provided in drawings and specifications.
6.) Create assembly drawings including bill of materials.*	5.3.4.	Perform part manipulation during the creation of an assembly model.
	5.3.5.	Analyze assembly constraints to successfully construct a multipart object.
	5.3.6.	Utilize part libraries effectively during the assembly modeling process.
	5.3.7.	Employ subassemblies during the production of assemblies.
	5.3.8.	Verify drive constraints that simulate the motion of parts in assemblies.

	5.3.9.	Apply adaptive design concepts during the development of sketches, features, parts, and assemblies.
	5.3.17.	Add technical illustrations (e.g., parts lists, titles, finishes, tolerances, specifications, hidden surfaces) to drawings.
	6.1.4.	Identify information and symbols typically provided in drawings and specifications.
	6.2.1.	Determine product requirements, dimensions, and tolerances from drawing and specifications.
7.) Draw a multiple sheet/multiple part working drawing.	5.3.4.	Perform part manipulation during the creation of an assembly model.
	5.3.5.	Analyze assembly constraints to successfully construct a multipart object.
	5.3.6.	Utilize part libraries effectively during the assembly modeling process.
	5.3.7.	Employ subassemblies during the production of assemblies.
	5.3.8.	Verify drive constraints that simulate the motion of parts in assemblies.
	5.3.9.	Apply adaptive design concepts during the development of sketches, features, parts, and assemblies.
	5.3.10.	Translate a three-dimensional drawing or model into corresponding orthographic drawing views.
	5.3.17.	Add technical illustrations (e.g., parts lists, titles, finishes, tolerances, specifications, hidden surfaces) to drawings.
	6.1.4.	Identify information and symbols typically provided in drawings and specifications.
	6.2.1.	Determine product requirements, dimensions, and tolerances from drawing and specifications.
8.) Demonstrate a basic knowledge of 3D modeling.	5.3.2	Evaluate a sketch and generate a model utilizing three-dimensional modeling software and techniques.
	5.3.10.	Translate a three-dimensional drawing or model into corresponding orthographic drawing views.
9.) Gain an appreciation of the ANSI Y14.5M-1982 graphics standard by identifying and understanding the symbols and terminology.	1.2.1.	Extract relevant, valid information from materials and cite sources of information.
	1.4.6	Use electronic database to access and create business and technical information.

	5.2.3. Use tolerancing techniques when dimensioning. 5.2.4. Apply annotations on sketches and drawings. 5.2.6 Apply coordinate systems (e.g., absolute, relative, user, cylindrical, Cartesian). 5.3.17. Add technical illustrations (e.g., parts lists, titles, finishes, tolerances, specifications, hidden surfaces) to drawings. 6.1.4. Identify information and symbols typically provided in drawings and specifications.
10.) Understand the standard engineering symbols and prepare engineering diagrams.	5.2.4. Apply annotations on sketches and drawings. 5.3.17. Add technical illustrations (e.g., parts lists, titles, finishes, tolerances, specifications, hidden surfaces) to drawings. 6.1.4. Identify information and symbols typically provided in drawings and specifications.
11.) Prepare electrical connection wiring diagrams.	2.4.3. Identify symbols for electronic components. 2.5.6. Combine components per wiring prints, schematics, and block diagrams. 2.6.13. Design a schematic for a digital circuit. 2.9.5. Interpret schematics and control diagrams for building a motor circuit.
12.) Introduce Geometric Dimension & Tolerancing (GD&T)	1.2.1. Extract relevant, valid information from materials and cite sources of information. 1.4.6 Use electronic database to access and create business and technical information. 5.2.3. Use tolerancing techniques when dimensioning. 5.2.4. Apply annotations on sketches and drawings. 5.2.6. Apply coordinate systems (e.g., absolute, relative, user, cylindrical, Cartesian). 5.3.17. Add technical illustrations (e.g., parts lists, titles, finishes, tolerances, specifications, hidden surfaces) to drawings. 6.1.3. Identify measuring systems and convert between systems. 6.1.4. Identify information and symbols typically provided in drawings and specifications.

Engineering Manufacturing CTAG Alignment

This document contains information about two Career-Technical Articulation Numbers (CTANs) for the Engineering Manufacturing Career-Technical Assurance Guide (CTAG).

The CTANs are:

1. CNC Programming/Machining	**Aligns to ODE course 176007**
2. Manufacturing Processes (TAG course OET 010)	**Aligns to ODE course 175003**

1. CNC Programming/Machining: CTAN alignment with the Engineering Science and Manufacturing Technology Pathway in the Career Field Technical Content Standards of the Ohio Department of Education.

General Course Description: This course introduces students to the fundamentals of manual programming for numerical control machines. Topics include CNC machine types, controls, safety, and coordinate measuring systems; speed and feed calculations; CNC tooling and fixturing; and programming CNC mills and lathes. Embedded CNC software is utilized for this course.

Advising Notes*:* Student must access credit within 3 years of program completion
Semester Credit Hours: 3

*****Learning Outcomes with an asterisk are essential and must be included in the course.

Learning Outcomes	**Competencies and/or Descriptors from the Engineering and Science and Manufacturing Technology Pathway of the Career Field Technical Content Standards**
1. *****Explain and apply common formats and codes for manual programming.	6.9.2 Plan a CNC production process for jobs in a machining cell. 6.9.3 Create and edit CNC programs (e.g., G-code, computer-aided manufacturing [CAM]) for milling/turning machine operations according to job specifications, dimensions, and tolerances. 6.9.4 Create a tool setup sheet. 6.9.5 Work from a process sheet and part print. 6.9.6 Set up and operate CNC milling/turning machines. 6.9.7 Monitor the operations of a machining cell and troubleshoot problems that arise. 6.9.8 Verify part quality against job specifications.
2. *****Create a manual CNC program.	6.9.3 Create and edit CNC programs (e.g., G-code, computer-aided manufacturing [CAM]) for milling/turning machine operations according to job specifications, dimensions, and tolerances.
3. *****Explain and document setup procedures for CNC lathes and mills.	6.9.4 Create a tool setup sheet.
4. Troubleshoot a manual CNC program.	1.1.7 Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions. 6.9.7 Monitor the operations of a machining cell and troubleshoot problems that arise.
5. *****Perform set-up procedures on a CNC machine.	6.9.6 Set up and operate CNC milling/turning machines.
6. *****Make the part to print specifications.	6.9.5 Work from a process sheet and part print. 6.9.6 Set up and operate CNC milling/turning machines. 6.9.7 Monitor the operations of a machining cell and troubleshoot problems that arise.
7. Explain secondary manual programming techniques.	6.10.1 Identify and explain additive manufacturing processes, technologies, and applications.

	6.10.2 Describe the steps of the additive manufacturing (e.g., pre-processing and post-processing. 6.10.3 Explain the costs involved in additive manufacturing. 6.10.5 Identify the tooling and equipment needs for additive manufacturing. 6.10.6 Setup additive manufacturing equipment. 6.10.7 Convert CAD files to stereolithography (STL) files.
8. Explain and demonstrate height compensation, cutter compensation, and tooling offset.	3.3.4 Program macro- and micro- instructions, conditional statements, and arithmetic variables and instructions. 3.3.5 Program, monitor, and operate universal inputs and outputs. 3.3.6 Create user frames. 3.3.7 Calibrate and modify tool control point (TCP). 3.3.8 Describe the use of subroutines. 3.3.10 Describe the various types used for import/export of 3D data. 3.3.11 Upload and download data between robotic simulations and programming a physical robot.

2. Manufacturing Processes Updated CTAN alignment with the Engineering and Manufacturing Pathway in the Career Field Technical Content Standards of the Ohio Department of Education. Aligns with TAG course OET 010.

General Course Description: The focus of this course is to provide the student with an introduction to common major manufacturing processes. Students will study and gain practical experience in various manufacturing processes such as metrology, materials, heat-treating, machine operations, metal forming, extrusions, castings, welding, finishing, adhesion, fasteners, assembly, and applications of empirical data to determine speeds and feeds to optimize production efficiencies. Learning outcomes are achieved through various in-class and laboratory experiences.

Advising Notes*:* Student must access credit within 3 years of program completion

Semester Credit Hours: 3

*****Learning Outcomes with an asterisk are essential and must be included in the course.

Learning Outcomes	**Competencies and/or Descriptors from the Engineering and Science and Manufacturing Technology Pathway of the Career Field Technical Content Standards**
1. *****Demonstrate an understanding of the interrelationships between material properties and manufacturing processes.	5.4.1 Compare advantages of materials used in manufacturing based on physical properties. 5.4.2 Identify the production processes used to create materials. 5.4.3 Determine the production processes used to create products from categories of materials (e.g., organic materials, metals, polymers, ceramics, and composites). 5.4.5 Analyze material properties by destructive and nondestructive tests. 5.4.6 Select materials for a given application based on specified criteria (e.g., cost, availability, manufacturability). 5.5.1 Plan and apply manufacturing processes (e.g., casting, molding, forming, separating, conditioning, assembling, finishing, rapid prototyping, 3-D printing). 5.5.2 Use process planning and improvement tools (e.g., flowcharts, diagrams, design for manufacturability [DFM]). 5.5.5 Employ project-scheduling techniques (e.g., critical path methodology [CPM], project evaluation and review techniques [PERT]). 5.5.7 Estimate time, tooling, product packaging, and material costs.

	5.5.8 Monitor performance and compare to time, too, and material cost estimates. 5.5.9 Set capacity to account for fluctuation in demand. 5.5.10 Adjust the plan as necessary to respond to variations (e.g., process, demand, material).
2. *****Distinguish between different manufacturing processes such as forgings, extrusions, castings, forming, and finishing.	5.5.1 Plan and apply manufacturing processes (e.g., casting, molding, forming, separating, conditioning, assembling, finishing, rapid prototyping, 3-D printing).
3. Distinguish between different fabrication processes such as welding, fasteners, and adhesives.	4.3.2 Select the types of weld required for product specifications. 4.3.4 Select an arc welding process based on product specifications. 4.4.2 Select the types of material joining required for product specifications. 4.7.7 Identify various methods of fastening materials.
4. *****Apply process parameters to optimize production efficiencies.	6.2.1 Determine product requirements, dimensions, and tolerances from drawing and specifications. 6.2.2 Determine process steps (e.g., cut, drill, turn, mill, grind, heat treat). 6.2.3 Plan individual processes steps based on industry standards (e.g., manufacturer's specification, machining standards). 6.2.4 Schedule machining equipment as required. 6.8.1 Identify equipment maintenance requirements in the equipment manufacturer's documentation. 6.8.2 Identify maintenance tasks required (e.g., inspecting, grinding, sharpening, dressing, lubricating, cleaning). 6.8.3 Verify measuring tool accuracy and recalibrate as needed. 6.8.4 Develop a preventive maintenance schedule. 6.8.5 Monitor equipment performance during use. 6.8.6 Repair or replace equipment and accessories as needed.
5. *****Demonstrate appropriate safety procedures and methods in a manufacturing setting.	7.1.1 Use Occupational Safety and Health Administration (OSHA)-defined procedures for identifying employer and employee responsibilities, working in confined spaces, managing worker safety programs, using ground fault circuit interrupters (GFCIs), maintaining clearance and boundaries, and labeling. 7.1.2 Identify and rectify or mitigate hazards associated with walking surfaces, working surfaces, and lighting. 7.1.3 Calculate example of load factors for constructing scaffolding, railings, ladders, and temporary structures. 7.1.4 Apply inspection, rejection criteria, hitch configurations, and load-handling practices to slings and rigging hardware. 7.1.5 Demonstrate proper use of American National Standards Institute (ANSI) hand signals. 7.1.6 Identify source of electrical and mechanical hazards and use shut down and established lock-out/tag-out procedures 7.1.7 Identify and eliminate worksite clutter in accordance with standards for cleanliness and safety. 7.1.8 Identify procedures for handling, storage, and disposal of hazardous materials. 7.1.9 Identify the location of emergency flush showers, eyewash fountains, Safety Data Sheets (SDSs), fire alarms, and exits. 7.1.10 Select and operate fire extinguishers based on the class of fire. 7.1.11 Identify the components of a hazardous materials safety plan. 7.1.12 Create a hazardous materials safety plan.

	7.1.13 Set up for ergonomic workflow. 7.1.14 Describe the interactions of incompatible substances when measuring and mixing chemicals.
6. *****Demonstrate proficiency in the use of measurement instruments.	6.1.1 Identify measuring tools and gradations used in precision machining and their purposes. 6.1.2 Identify typical measurements in precision machining (e.g., angles, diameter, hardness). 6.1.3 Identify measuring systems and convert between systems. 6.1.4 Identify information and symbols providing in drawings and specifications. 6.1.5 Measure and inspect work pieces according to product specifications.