

FY2027 Manufacturing Career Field Pathways and Course Structure

Criteria for Course/Model Development

1. Courses are designed to attract student enrollment.
2. The Courses are designed to fit in a comprehensive middle and high school model typically offering 40-50 minutes per day (120-150 hours/year) as well as a career center model typically offering 120-150 minutes per day (360-450 hours/year).
3. There are no prerequisite course requirements.
4. The course structure must facilitate testing using CTE Technical tests.
5. Recommended first course in career field is indicated by a (1)
6. Each Pathway has a recommended “first course in the pathway” that is designated with a (2).
7. Courses that carry Career Technical Assurance Guide (CTAG) credit are marked by a (3).
8. Program of Study should align with in-demand occupations which requires the skillsets modeled in the course outlines.
9. The pathway course structure should align with postsecondary programs for enhancing successful articulation.
10. Programs must be comprised of a minimum of four courses from the pathway courses. Additional courses can come from the pathway. The Capstone course must be taught in addition to the four-course minimum. There is no maximum on the number of courses.

Assessment Considerations

1. Assessments will be developed for every course except the Capstone course.
2. It is recommended that students sit for course assessments after the completion of the course.

Program of Study Requirements

1. CTE-26 Application, Program of Study, and Assurances must be approved.
2. Coursework includes articulated credit that is directly related to the secondary/postsecondary Career Field. Postsecondary credit will be transcribed no later than the conclusion of the term in which the student has met the postsecondary residency requirements.
3. Program of Study provides educational experiences to prepare the student for state or industry recognized assessment and the appropriate state technical competency assessment.
4. College-ready assessments (Compass, Asset, ACT) must be accessible to all students.

Manufacturing Career Field Pathways and Course Descriptions

R7 Precision Machining	R8 Metallurgy	R9 Advanced Manufacturing
• Manufacturing Processes² • Manufacturing Operations^{1,3} • Machine Operations • Machining with Industrial Lathes • Machining with Industrial Mills • CNC Programming and Machining³ • Industrial Robotics³ • Computer Aided Drafting & Modeling³ • Industrial Maintenance • Fluid Mechanics³ • Welding Technologies • Manufacturing Capstone	• Welding Technologies² • Gas Metal Arc Welding (GMAW) • Shield Metal Arc Welding (SMAW) • Flux Cored Arc Welding (FCAW) • Gas Tungsten Arc Welding (GTAW) • Welding Fabrication • Manufacturing Operations^{1,3} • Industrial Robotics³ • Manufacturing Capstone	• Manufacturing Operations^{1,3} • Engineering Principles • Principles of Advanced Manufacturing^{2,3} • Computer Aided Drafting & Modeling³ • Automation Technologies³ • Industrial Robotics³ • CNC Programming and Machining³ • Battery Technology • Fluid Mechanics³ • Introduction to Semiconductors³ • Vacuum Systems³ • Industrial Maintenance • Applications of Artificial Intelligence • Operations Management • Manufacturing Capstone

Manufacturing Career Field Pathways and Course Descriptions

Courses in Precision Machining (R7)

Pathway Course Name	Subject Code
Manufacturing Processes	176050
Manufacturing Operations	175003
Machine Operations	176004
Machining with Industrial Lathes	176005
Machining with Industrial Milling Machines	176006
CNC Programming and Machining	176007
Industrial Robotics	176025
Computer Aided Drafting and Modeling	175006
Industrial Maintenance	176020
Fluid Mechanics	176045
Welding Technologies	176009
Manufacturing Capstone	176008

Manufacturing Processes

Subject Code: 176050

Students develop foundational skills in manufacturing by exploring a variety of production methods and processes. Through hands-on learning and technical analysis, they gain experience in areas such as machining, electronics, material selection, and blueprint interpretation. Emphasis is placed on process planning, quality control, and safe work practices to support efficient and sustainable manufacturing operations.

Manufacturing Operations

Subject Code: 175003

Learners develop practical knowledge and skills related to manufacturing operations in terms of production planning, quality control, and workplace safety. The course emphasizes understanding various manufacturing methods, equipment operation, and the coordination of resources to efficiently produce goods. Students gain hands-on experience in monitoring production lines, maintaining equipment, and implementing continuous improvement practices.

Machine Operations

Subject Code: 176004

This course covers precision machining using both manual and CNC equipment. Learners develop skills in operating lathes, mills, grinders, and other machines, performing subtractive and additive manufacturing processes. Emphasis is placed on interpreting technical drawings, selecting appropriate tooling, programming CNC machines, and conducting accurate measurements and inspections to ensure quality. Students gain hands-on experience with machining techniques, tooling setup, and quality control for a comprehensive foundation in modern manufacturing operations.

Machining with Industrial Lathes

Subject Code: 176005

Students will use these machine tools to shape, pattern, bore, thread and polish metal and other materials. Students will apply their knowledge of product characteristics, perform necessary calculations, use precision measuring instruments and make all adjustments needed to fabricate products to print dimensions. Students will be able to identify operational problems and provide routine care and maintenance to the lathe.

Machining with Industrial Milling Machines

Subject Code: 176006

Students apply their knowledge of product characteristics, perform necessary calculations, and use precision measuring instruments and layout equipment to mill products to print dimensions. Students will use these machine tools to shape, cut, drill and bore metal and other materials. Students will be able to identify operational problems and provide routine care and maintenance to the manual mill.

CNC Programming and Machining

Subject Code: 176007

Learners apply CNC principles to select materials, plan machining processes, interpret blueprints, and operate CNC machines. They develop skills in programming, setup, precision machining, and part inspection, ensuring accurate, efficient, and safe CNC production.

Industrial Robotics

Subject Code: 176025

Learners explore the fundamentals of industrial robots, including their design, operation, and applications in manufacturing and automation. The course covers robot types, kinematics, sensors, actuators, programming, and safety protocols. Emphasis is placed on integrating robots into production systems for tasks such as assembly, welding, material handling, and inspection, alongside troubleshooting and maintenance practices.

Computer Aided Drafting and Modeling

Subject Code: 175006

Learners develop skills in creating precise technical drawings and 3D models using computer-aided design (CAD) software. The course emphasizes understanding drafting standards, interpreting engineering drawings, and applying modeling techniques for design visualization and product development. Students gain hands-on experience in producing detailed plans and digital prototypes that support engineering and manufacturing processes.

Industrial Maintenance

Subject Code: 176020

Prepares students to diagnose, maintain, and support the interconnected systems that drive modern manufacturing operations. Through hands-on, technical problem-solving, students develop the ability to interpret technical documentation, safely service equipment, and restore functionality to complex industrial systems to ensure reliability, efficiency, and continuous production in advanced manufacturing environments.

Fluid Mechanics

Subject Code: 176045

Students will explore the operation, installation, and maintenance of mechanical, hydraulic, pneumatic, and pumping systems used in manufacturing. Emphasis is placed on motors, drives, schematics, and fluid power systems. Learners will analyze schematics, calculate performance metrics, and troubleshoot real-world issues. Safety practices, personal protective equipment, and regulatory compliance are integrated throughout to prepare students for safe, effective work in modern engineering and industrial environments.

Welding Technologies

Subject Code: 176009

Learners develop skills in welding processes, metallurgy, joint design, and weld testing. They apply principles of arc and non-arc welding, select appropriate materials and parameters, and evaluate weld quality using industry standards.

Manufacturing Capstone

Subject Code: 176008

The capstone course provides opportunities for students to apply knowledge, attitudes and skills that were learned in a Manufacturing program in a more comprehensive and authentic way. Capstones often include project/problem-based learning opportunities that occur both in and away from school. Under supervision of the school and through community partnerships, students may combine classroom learning with work experience. This course can be delivered through a variety of delivery methods including cooperative education or apprenticeship.

Courses in Metallurgy (R8)

Pathway Course Name	Subject Code
Manufacturing Operations	175003
Welding Technologies	176009
Gas Metal Arc Welding (GMAW)	176000
Shielded Metal Arc Welding (SMAW)	176001
Flux Cored Arc Welding (FCAW)	176002
Gas Tungsten Arc Welding (GTAW)	176003
Welding Fabrication	176015
Industrial Robotics	176025
Manufacturing Capstone	176008

Manufacturing Operations

Subject Code: 175003

Learners develop practical knowledge and skills related to manufacturing operations in terms of production planning, quality control, and workplace safety. The course emphasizes understanding various manufacturing methods, equipment operation, and the coordination of resources to efficiently produce goods. Students gain hands-on experience in monitoring production lines, maintaining equipment, and implementing continuous improvement practices.

Welding Technologies

Subject Code: 176009

Learners develop skills in welding processes, metallurgy, joint design, and weld testing. They apply principles of arc and non-arc welding, select appropriate materials and parameters, and evaluate weld quality using industry standards.

Gas Metal Arc Welding (GMAW)

Subject Code: 176000

Students will use the Gas Metal Arc Welding process (GMAW) to safely join various types of metal. They will cut metals using oxy-fuel processes and perform multiple types of welds and joints in all positions, up to and including overhead. They will select the appropriate type of electrode wire and shielding gas, and they will adjust welding equipment based on the physical characteristics and metal properties. Students will apply quality control factors to evaluate weld quality.

Shielded Metal Arc Welding (SMAW)

Subject Code: 176001

Students will be able to use the Shielded Metal Arc Welding process (SMAW) to safely join various types of metal. They will perform multiple types of welds and joints in all positions, up to and including overhead. They will select the appropriate type of electrode and adjust welding equipment based on the physical characteristics and properties of the metal. Students will apply quality control factors to evaluate the quality of welds.

Flux Cored Arc Welding (FCAW)

Subject Code: 176002

Students will be able to use the Flux Cored Arc Welding process (FCAW) to safely join various types of metal. They will perform multiple types of welds and joints in all positions up to and including overhead. They will select the appropriate type of cored electrode wire and adjust welding equipment based on the physical characteristics and properties of the metal. Students will apply quality control factors to evaluate the quality of welds.

Gas Tungsten Arc Welding (GTAW)

Subject Code: 176003

Students will use the Gas Tungsten Arc Welding process (GTAW) to safely join various types of metal. They will perform multiple types of welds and joints in all positions, up to and including overhead. They will select the appropriate type of electrode, filler metal and shielding gas. They will be able to adjust welding equipment based on the physical characteristics and properties of the metal. Students will apply quality control factors to evaluate weld quality.

Welding Fabrication

Subject Code: 176015

Students will apply the knowledge and skills necessary to safely fabricate parts by cutting, drilling, bending, shaping, forming, edging and assembling stock to drawing dimensions. Students will identify weld types, fasteners and adhesives to join materials.

Industrial Robotics

Subject Code: 176025

Learners explore the fundamentals of industrial robots, including their design, operation, and applications in manufacturing and automation. The course covers robot types, kinematics, sensors, actuators, programming, and safety protocols. Emphasis is placed on integrating robots into production systems for tasks such as assembly, welding, material handling, and inspection, alongside troubleshooting and maintenance practices.

Manufacturing Capstone

Subject Code: 176008

The capstone course provides opportunities for students to apply knowledge, attitudes and skills that were learned in a Manufacturing program in a more comprehensive and authentic way. Capstones often include project/problem-based learning opportunities that occur both in and away from school. Under supervision of the school and through community partnerships, students may combine classroom learning with work experience. This course can be delivered through a variety of delivery methods including cooperative education or apprenticeship.

Courses in Advanced Manufacturing (R9)

Pathway Course Name	Subject Code
Engineering Principles	175002
Manufacturing Operations	175003
Principles of Advanced Manufacturing	176035
Computer Aided Drafting & Modeling	175006
Automation Technologies	176055
Industrial Robotics	176025
CNC Programming and Machining	176007
Battery Technology	176060
Fluid Mechanics	176045
Introduction to Semiconductors	176030
Vacuum Systems	176040
Industrial Maintenance	176020
Applications of Artificial Intelligence	145130
Operations Management	142020
Manufacturing Capstone	176008

Engineering Principles

Subject Code: 175002

Learners explore foundational concepts and practices across engineering fields, emphasizing mechanics, materials science, electrical principles, and fluid dynamics. The course focuses on applying these principles to analyze, design, and optimize engineering systems. Students develop critical thinking and problem-solving skills essential for understanding both mechanical and electrical components in engineering applications.

Manufacturing Operations

Subject Code: 175003

Learners develop practical knowledge and skills related to manufacturing operations in terms of production planning, quality control, and workplace safety. The course emphasizes understanding various manufacturing methods, equipment operation, and the coordination of resources to efficiently produce goods. Students gain hands-on experience in monitoring production lines, maintaining equipment, and implementing continuous improvement practices.

Principles of Advanced Manufacturing

Subject Code: 176035

This course introduces students to modern manufacturing organizations, technology, business systems, and problem solving. Provides the fundamentals of Lean Manufacturing, Quality Systems and Statistical Process Control, documentation and standard operating procedures, concepts in measurement, geometric dimensioning and tolerancing, visualization and graphics.

Computer Aided Drafting and Modeling

Subject Code: 175006

Learners develop skills in creating precise technical drawings and 3D models using computer-aided design (CAD) software. The course emphasizes understanding drafting standards, interpreting engineering drawings, and applying modeling techniques for design visualization and product development. Students gain hands-on experience in producing detailed plans and digital prototypes that support engineering and manufacturing processes.

Automation Technologies

Subject Code: 176055

Students develop skills in automating manufacturing processes through the integration of robotics, programmable logic controllers (PLCs), and control systems. They design, program, and troubleshoot automated work cells using schematics, blueprints, and simulation software. Emphasis is placed on optimizing robotic operations, configuring sensors and actuators, and improving system efficiency. Learners apply automation tools to streamline production, monitor data for continuous improvement, and ensure safe, high-performance manufacturing environments.

Industrial Robotics

Subject Code: 176025

Learners explore the fundamentals of industrial robots, including their design, operation, and applications in manufacturing and automation. The course covers robot types, kinematics, sensors, actuators, programming, and safety protocols. Emphasis is placed on integrating robots into production systems for tasks such as assembly, welding, material handling, and inspection, alongside troubleshooting and maintenance practices.

CNC Programming and Machining

Subject Code: 176007

Learners apply CNC principles to select materials, plan machining processes, interpret blueprints, and operate CNC machines. They develop skills in programming, setup, precision machining, and part inspection, ensuring accurate, efficient, and safe CNC production.

Battery Technology

Subject Code: 176060

Students examine battery technology with a focus on design, function, and manufacturing. They explore battery chemistries, energy storage principles, and performance factors such as capacity, efficiency, and lifespan. Students study battery production processes, materials, and environmental impacts, while learning to test, select, and safely handle batteries for various applications. Emphasis is placed on emerging technologies, industry standards, and the critical role of batteries in modern electrical and electronic systems.

Fluid Mechanics

Subject Code: 176045

Students will explore the operation, installation, and maintenance of mechanical, hydraulic, pneumatic, and pumping systems used in manufacturing. Emphasis is placed on motors, drives, schematics, and fluid power systems. Learners will analyze schematics, calculate performance metrics, and troubleshoot real-world issues. Safety practices, personal protective equipment, and regulatory compliance are integrated throughout to prepare students for safe, effective work in modern engineering and industrial environments.

Introduction to Semiconductors

Subject Code: 176030

This course is a broad introduction to semiconductor and integrated circuit manufacturing from a technician and maintenance perspective. In lecture, students will learn about what a cleanroom is, why it's important to gown up, and have a broad non-quantitative introduction to semiconductor processing. In the lab students will use hand-tools to perform inspection, maintenance and repair of mechanical fasteners and fixtures associated with semiconductor equipment, and gown up to simulate working in a bunny suit.

Vacuum Systems

Subject Code: 176040

This class focuses on the mechanical maintenance, processing, and data collection of vacuum systems typically used in semiconductor processes such as thin film deposition, ion implantation, and reactive ion etching. The lectures consist of a broad introduction to the use of vacuum pumps in semiconductor manufacturing and how to measure vacuum pressure within a multi-pump system. In Lab, students will gown up in a bunny suit and simulate working in a cleanroom environment.

Industrial Maintenance

Subject Code: 176020

Prepares students to diagnose, maintain, and support the interconnected systems that drive modern manufacturing operations. Through hands-on, technical problem-solving, students develop the ability to interpret technical documentation, safely service equipment, and restore functionality to complex industrial systems to ensure reliability, efficiency, and continuous production in advanced manufacturing environments.

Applications of Artificial Intelligence

Subject Code: 145130

This course will prepare students to apply artificial intelligence, machine learning, and neural networks to common workflows, processes, and problems in programming and design. Students will analyze the broader societal, technological, and ethical impacts and implications of its usage and development. Students will learn how to construct prompts and queries and how to critically analyze generated responses.

Operations Management

Subject Code: 142020

Operations Management explores how to plan, organize and monitor day-to-day business activities. Learners will develop knowledge and skills to plan production activities, promote workplace safety and manage inventory, quality control and operational risk. This course also includes learning outcomes in facilities management and managerial accounting.

Manufacturing Capstone

Subject Code: 176008

The capstone course provides opportunities for students to apply knowledge, attitudes and skills that were learned in a Manufacturing program in a more comprehensive and authentic way. Capstones often include project/problem-based learning opportunities that occur both in and away from school. Under supervision of the school and through community partnerships, students may combine classroom learning with work experience. This course can be delivered through a variety of delivery methods including cooperative education or apprenticeship.