THE REGISTERED APPRENTICESHIP OCCUPATIONS AND STANDARDS CENTER OF EXCELLENCE (AOSC)

Mechanical Engineering Technician National Occupational Framework

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Introduction to Using This Document

Under the Registered Apprenticeship Technical Assistance Centers of Excellence award, the Urban Institute leads the Occupations and Standards work. One of the main objectives of Urban's project is to create high-quality, well-researched, consensus-based work process schedules that are nonproprietary and widely available. This document is a product of that work and contains three sections: the occupational overview, the work process schedule, and the related technical instruction.

The **occupational overview** is a general introduction, including alternative job titles, any prerequisites, and, if applicable, the total number of hours needed to complete a time-based or hybrid program.

The **work process schedule** outlines the major job functions, competencies, and/or hours an apprentice completes in a registered apprenticeship program. It outlines what apprentices are expected to learn on the job with the support of a mentor or journeyworker (a worker mastering the competencies of an occupation in a particular industry), including both core competencies and those deemed optional by experts in the field. The work process schedule is the foundational document guiding a program.

Urban works with numerous experts to ensure the content is thoroughly researched and vetted to reflect the expectations of industry, educators, labor unions, employers, and others involved in apprenticeship for this occupation. Sponsors and employers can use the work process schedule as their program standards with assurances it has been approved by experts in the field.

The **related technical instruction** presents considerations for the coursework that apprentices will undertake to supplement on-the-job learning. It is intended to serve as a reference to sponsors exploring their options for the accompanying classroom, virtual, or hybrid training.

How to Use the Work Process Schedule

Sponsors can adapt the work process schedule to accommodate their needs for competency- or time-based or hybrid programs. In a **competency-based** apprenticeship, sponsors assess apprentices' progress across core and optional competencies listed in the work process schedule. In a **time-based** apprenticeship, apprentices complete a predetermined number of hours across major job functions and the program overall. In a **hybrid** apprenticeship, sponsors monitor apprentices' hours spent on major job functions and assess their proficiency across competencies.

Each program type has a different method of assessment:

- **For a competency-based program**, apprentices engage in activities and make progress toward proficiency in the identified competencies. Sponsors overseeing apprentices' work assess their mastery of the outlined competencies using the following rating scale:

  4—Competent/proficient (able to perform all elements of the task successfully and independently)

  3—Satisfactory performance (able to perform elements of the task with minimal assistance)

  2—Completed the task with significant assistance

  1—Unsuccessfully attempted the task

  0—No exposure (note the reason—absence, skill isn't covered, etc.)

  The competencies may be completed in any order. Apprentices must perform at a level 4 or 3 in all competencies listed as "core" to complete the apprenticeship program successfully.

- **For a time-based program,** sponsors monitor apprentices' completion of hours in training across major job functions. The total number of hours recommended for this occupation is listed in the occupational overview and is based on guidance from the US Department of Labor. Generally, apprentices must have at least 2,000 hours overall for on-the-job learning, but occupations of greater complexity may require more hours. Sponsors will provide apprentices with supervised work experience and allocate the total number of hours across the major job functions to adequately train their apprentices.

- **The hybrid approach** blends both competency- and time-based strategies. Sponsors measure apprentices' skills acquisition through a combination of completing the minimum number of hours of on-the-job learning successfully demonstrating identified competencies. Sponsors will assess apprentices' proficiencies as described for competency-based programs with a rating scale of 0–4 for every core competency. Generally, apprentices have at least 2,000 hours overall for on-the-job learning, but occupations of greater complexity may require more hours. Sponsors will document apprentices' completion within a minimum and maximum range of hours assigned for each major job function.

Mechanical Engineering Technician Occupational Overview

Occupational Purpose and Context

The Mechanical Engineering Technician role aims to bridge a gap between the production floor and the primary engineer team or drafting room. It is anticipated that apprentices will split their time between everyday machine operation and quality control and being a production floor consultant to the engineering team. Although experience in fabrication and assembly are core to becoming proficient in this occupation, these job functions secure a fundamental knowledge base for the individual rather than encapsulating the primary daily work operations of the apprentice. Understanding the fundamental components of basic engineering in collaboration with practical machine operation, fabrication, and assembly creates a more flexible employee who can easily adapt to the needs of any given business. This occupation is not to be used to prepare an individual for a lead or supervising engineer role.

Potential Job Titles

Engineering laboratory technician (engineering lab technician), engineering technical analyst, engineering technician (engineering tech), engineering technologist, manufacturing engineering technician (manufacturing engineering tech), mechanical designer, mechanical technician (mechanical tech), process engineering technician (process engineering tech), process technician, research and development technician (R and D tech)

Apprenticeship Prerequisites

Apprentices should have a basic understanding of algebra (roughly equivalent to Algebra 1 and 2 at the high school level) and basic computer skills.

Recommended Length of Apprenticeship (Time/Hybrid Programs Only)

The recommended length of time for on-the-job training in a mechanical engineering technician apprenticeship is 4,000–6,000 hours. (Note: there are no required hours for competency-based apprenticeship programs for registration in most states.)

Work Process Schedule

Mechanical Engineering Technician

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Instructions for Use:

Competency-based programs: In the “performance level achieved” column of the work process schedule (see examples starting on the next page), assess apprentices’ performances on each competency with the scale below. No monitoring of hours is required for this approach. See “Guidelines for Competency-Based, Hybrid and Time-Based Apprenticeship Training Approaches,” US Department of Labor, Employment and Training Administration, Office of Apprenticeship, October 20, 2015, https://www.apprenticeship.gov/sites/default/files/bulletins/Cir2016-01.pdf.

4—Competent/proficient (able to perform all elements of the task successfully and independently)

3—Satisfactory performance (able to perform elements of the task with minimal assistance)

2—Completed the task with significant assistance

1—Unsuccessfully attempted the task

0—No exposure (note the reason—absence, skill isn’t covered, etc.)

Time-based programs: In the “hours” row, specify the number of hours apprentices will fulfill for each job function. No assessment of competencies is required for this approach.

Hybrid programs: In the “performance level achieved” column, assess apprentices’ performances on each competency using the 0–4 scale above. In the “hours” row, identify a range of hours apprentices should spend working on each major job function.

Job Function 1: Collaborates with engineers on design and drafting for production		
Hours **(time-based and hybrid programs only):**		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Assists in the design of devices and tools for use in the manufacturing process, including jigs, fixtures, molds, dies, and Computer Aided Design (CAD) blueprints	Core	
B. Provides insight on sketches of components, equipment, and systems, with related specifications at the request of engineers	Core	
C. Aids in the evaluation and modification of designs and specifications for quality and accuracy	Core	
D. Utilizes the business's standard software (i.e., SolidWorks, Fusion 360, AutoCAD, CADcam, ICME) to produce 3D models and 2D drawings	Core	
E. Collaborates with engineers in the design of specialized or customized equipment, machines, or structures	Core	
F. Utilizes standard geometric dimensioning and tolerancing (GD&T) language as defined by the American Society of Mechanical Engineers	Core	
G. Produces prototypes using 3D-printing technology	Optional	
H. Collaborates with engineers to detail drawings or sketches for production and/or to request parts fabrication by machine, sheet metal or wood shops	Optional	

Job Function 2: Fabricates mechanical components and products		
Hours **(time-based and hybrid programs only):**		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Reads blueprints, travelers, and other work processes to determine and complete fabrication needs	Core	
B. Selects cutting tools according to written specifications or knowledge of metal properties and shop mathematics	Core	

C. Fabricates mechanical components and products using the necessary tools, instruments, materials, and techniques as needed	Core	
D. Demonstrates proficiency with both manual tools and power tools as needed for fabrication	Core	

Job Function 3: Assembles mechanical equipment and systems		
Hours (time-based and hybrid programs only):		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Determines material requirements and operational sequences by reviewing blueprints, layouts or charts, and job orders for information on specifications and tooling instructions	Core	
B. Assembles and disassembles complex mechanical equipment and systems, documenting this process using a traveler, a document that accompanies a product through its manufacturing process	Core	
C. Demonstrates proficiency with both manual tools and power tools	Core	
D. Inspects parts for quality against drawings	Core	
E. Inspects sample workpieces to verify conformance with specifications, using instruments such as gauges, micrometers, and dial indicators	Core	

Job Function 4: Operates and monitors machines according to organization guidelines		
Hours (time-based and hybrid programs only):		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Interprets and follows Bills of Materials, Bills of Process, routings, operation sheets, GD&T guidelines and other engineering documents and specifications	Core	
B. Collects accurate data by reading analog and digital test equipment, including measuring devices and meters	Core	

C. Moves toolholders manually or by turning handwheels, or engage automatic feeding mechanisms to feed tools to and along workpieces	Core	
D. Modifies and adjusts equipment in response to test results as necessary	Core	
E. Refills, changes, and monitors the level of fluids, such as oil and coolant, in machines	Core	
F. Monitors tool wear and inspects for quality before resuming production	Core	
G. Monitors scrap and waste materials to identify changes in production and ensure product quality	Core	

Job Function 5: Monitors machinery and performs tests to ensure product quality		
Hours **(time-based and hybrid programs only):**		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Monitors productivity and efficiency of industrial operations via dashboards	Core	
B. Conducts partial First Article Inspections (FAIs) to confirm that products meet the specified dimensions and features	Core	
C. Monitors machine operations for efficiency	Core	
D. Communicates test results and inefficiencies in production to engineering colleagues	Core	
E. Conducts F3 (form, fit, and function) part testing in-situ	Optional	
F. Collaborates with engineers to develop additional tests to evaluate materials, machines, and products for a variety of characteristics (i.e., performance, strength, response to stress, functionality, quality, dimensional accuracy, and GD&T)	Optional	
G. Records the entire testing process, including procedures, results, and response	Optional	
H. Sets up prototype and test apparatus and operates test controlling equipment to observe and record prototype test results	Optional	

Job Function 6: Follows policies and procedures to ensure safety		
Hours **(time-based and hybrid programs only):**		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Demonstrates knowledge of organizational policies	Core	
B. Follows job safety guidelines, including the use of personal protective equipment	Core	
C. Follows all work safety standards such as American National Standards Institute (ANSI), International Organization for Standardization (ISO), and Occupational Safety and Health Administration (OSHA) and all policies and practices established by company	Core	
D. Recognizes personal limitations and realizes the importance of collaboration with the entire technical team	Core	
E. Accesses and utilizes Safety Data Sheets (SDSs) to identify hazardous materials and respond appropriately in the event of an emergency	Core	
F. Follows all equipment safety procedures, including lockout–tagout	Core	

Job Function 7: Communicates and collaborates with other team members		
Hours **(time-based and hybrid programs only):**		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Demonstrates appropriate professional communication practices with colleagues regardless of race, sex, sexual orientation, disability, cultural, or social background	Core	
B. Exhibits effective communication skills, including the ability to promote potential projects and discuss ongoing production	Core	
C. Provides support to other team members by translating and explaining technical information relating to mechanical design, fabrication, testing, and documentation	Core	

D. Works with team members to diffuse and resolve conflict	Core	
E. Effectively functions as a part of a diverse, multidisciplinary team	Core	
F. Follows appropriate communication channels based on incident response procedures	Core	

Job Function 8: Demonstrates appropriate work styles		
Hours **(time-based and hybrid programs only):**		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Demonstrates ability to apply critical thinking and analysis to job duties	Core	
B. Manages multiple projects and deadlines independently	Core	
C. Demonstrates flexibility to change work tasks as needed	Core	
D. Demonstrates adaptability to new processes and projects	Core	
E. Shows attention to detail throughout the production process to maintain quality control	Core	
F. Demonstrates willingness to continue to learn new techniques, new technologies, and other career learning throughout the profession	Core	
G. Exhibits high ethical standards and shares in the protection of the health, safety, and welfare of the workplace	Core	
H. Exhibits timeliness and responsibility for one's actions	Core	
I. Demonstrates good attendance in accordance with project timelines	Core	

Job Function 9: Prepares technical documents and estimates for project development		
Hours **(time-based and hybrid programs only):**		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Helps senior technicians and engineers determine project feasibility given equipment limitations and the required capacities of equipment to obtain specified performance	Core	
B. Aids in estimating production and operations information (i.e., costs, capacities) at the request of lead engineers or estimators	Optional	
C. Completes progress reports and proper documentation such as, forms, travelers, parts sketches, and other technical documents under the supervision of senior technicians and engineers	Optional	
D. Schedules operational activities, inspections, and quality assurance checks	Optional	
E. Aids in estimating cost factors including labor and material for purchased and fabricated parts and costs for assembly, testing, or installing at the request of estimators or lead engineers	Optional	
F. Develops operations sheets and routing instructions	Optional	
G. Assists in creating and updating single-level and multilevel bills of materials (BOMs) under supervision and direction of senior technicians and engineers	Optional	

Related Technical Instruction

Mechanical Engineering Technician

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Instructions for Use:

Registered apprenticeships must include at least 144 hours of related technical instruction (RTI). Courses offered by accredited colleges and universities may be assigned a credit hour determination rather than a contact hour determination. In general, an academic credit unit is the equivalent of 15 clock hours of instruction.

Development and Use of This RTI Outline: Employers and academic institutions may approach RTI in markedly different ways. Our goal was not to identify the single best way to provide RTI or to identify a single provider whose content we deemed to be superior. Instead, our goal was to survey numerous education providers, including employers, institutions of higher education, high schools, private continuing education providers, labor organizations, professional associations and, in some cases, municipalities that provide worker training, to identify topics or courses common among those providers that align with the job functions included in this work process schedule. Those common topics or courses are reflected in the RTI outline provided below, which may be useful in developing your RTI program or communicating your needs to an educational partner.

Licensure or certification requirements: Most states do not require mechanical engineering technicians to be licensed; however, many employers give hiring priority or require engineering technicians to be certified by the National Institute for Certification in Engineering Technologies, which offers certifications in civil, electrical, mechanical systems and fire alarm systems. The Society of Manufacturing Engineers (SME) offers certification opportunities at several competency levels, including the Certified Manufacturing Associate Certification (CMfgA) for entry-level workers, and the Certified Manufacturing Technologist Certification (CMfgT) for those with four years of combined mechanical engineering education and work experience. SME also recommends that mechanical engineers consider seeking certification in their area of work specialty, such as the Manufacturing Skill Standards Council (MSSC) Certified Production Technician credential, the National Institute for Metalworking Skills (NIMS) machining and industrial maintenance certification, or the American Welding Society (AWS) welding certification.

Degree requirements for licensure or certification, if applicable: The Society of Manufacturing Engineers offers the certified manufacturing technologist credential to those with at least four years of combined manufacturing-related education and/or work experience.
Accreditation requirements of instructional provider for licensure or certification, if applicable: N/A
Anticipated changes in licensure or certification requirements, if known: N/A
Examples of various certification requirements: Employers and apprentices should review the content guidelines issued by the certification body from which they wish to receive a credential. Some of these organizations offer several levels of certification in a variety of electronics specialty areas. **National Institute for Certification in Engineering Technologies**: This certification requires individuals to meet experience requirements, receive personal recommendations, and pass an exam. Certification is available in fire protection systems, security systems, and systems software integration. There are no degree requirements for technician-level certification, though certification as a technologist requires the applicant to have completed a four-year engineering degree. **Society of Manufacturing Engineers (SME)**: SME offers certifications for technicians and technologists at many levels and in many specialty areas, including: ▪ **the Certified Manufacturing Associate (CMfgA) credential** for entry-level workers who pass a body of knowledge exam ((https://www.sme.org/globalassets/sme) and a skills exam (https://www.sme.org/globalassets/sme.org/training/certifications/technical-certification/certified-manufacturing-associate-skills-guide.pdf); and ▪ **the Certified Manufacturing Technologist (CMfgT) credential** for individuals who have four years of combined education and work experience and who pass a certification exam (https://www.sme.org/training/technical-certification/certified-manufacturing-technologist-cmfgt/).

Examples of RTI providers for this occupation
Professional associations and labor organizations: The American Society for Mechanical Engineers (ASME) offers a variety of training and education programs, including a federally supported robotics institute that trains veterans to become robotics technicians. Information about the programs and courses offered by ASME can be found at https://learn.asme.org. **Military:** The United States military services provide training opportunities to military personnel to become mechanical engineering technicians at many levels and in many specialties. However, the military does not make these training opportunities available to civilians. **States/municipalities:** Many states offer educational opportunities related to state codes and requirements, though they do not generally offer instruction in foundational topics of electronics. **Colleges and universities:** Many community colleges offer applied associate of science (AAS) degree programs in engineering technology. Four-year colleges may accept some credits from AAS programs toward baccalaureate degrees in engineering or computer science; however, credits earned in applied

courses may not be accepted for transfer credit or may not be applied to meet baccalaureate degree requirements.

No-cost online providers: Coursera and EdX offer courses in physics, electronics, and mathematics that may be helpful to engineering technology apprentices. However, these online providers do not offer full programs in engineering technology.

Continuing education or specialty education providers: The Institute of Electrical and Electronics Engineers offers continuing education opportunities in engineering, computing, and information technology.

Prerequisite knowledge, skills or experience typically required by RTI providers for this occupation

Mechanical engineering technicians are typically expected to have strong interests in math and science as well as a strong interest in mechanical systems or electronics.

Mechanical engineering technicians that work for or as a contractor or subcontractor to the US government, including the US Military Services, may be required to pass a background check and obtain a security clearance.

Technical Mathematics

(*) indicates knowledge and skills listed in the SME's "Certified Manufacturing Associate Body of Knowledge"

Hours: 35–45 **(these hours correlate to a typical three-credit technical mathematics course)**

Sample learning objectives

- Perform calculations involving addition, subtraction, multiplication, and division. (*)
- Convert fractions to decimals and decimals to fractions; add, subtract, multiply and divide fractions and decimals and calculate proportions and ratios. (*)
- Calculate rates of change.
- Calculate percentages and use percentages to determine the amount of materials to use. (*)
- Measure properly using a tape measure, convert between measurement systems (such as English to metric), and determine unknown measurements using algebra, geometry, or trigonometry. (*)
- Use scientific notation and manipulate numbers expressed with exponents.
- Use algebraic techniques to solve for unknown variables, solve linear equations, follow correct order of operations, use the distributive law, and solve systems of equations.
- Define the various types and components of triangles, determine interior and exterior triangle angles, use the Pythagorean Theorem to solve problems for right triangles, and determine perimeter and area of triangles.

- Identify squares, rectangles, parallelograms, trapezoids, hexagons, octagons, pentagons, and quadrilaterals and calculate their perimeter and area.
- Calculate the diameter, radius, circumference, and arc of a circle.
- Use the Laws of Sines and Cosines to determine angles.
- Define and use mean, median, mode and standard deviation.
- Create and interpret graphs.

Occupational Safety in the Manufacturing Environment

(*) indicates knowledge and skills listed in the SME's "Certified Manufacturing Associate Body of Knowledge"

Hours: 10–20

Sample learning objectives

- Explain and demonstrate compliance with best practices for ensuring a safe work environment. (*)
- Explain OSHA regulations regarding hazardous materials. (*)
- Demonstrate proper and consistent use of appropriate Personal Protective Equipment. (*)
- Explain the importance of and demonstrate consistent application of lockout–tagout procedures. (*)
- Describe OSHA regulations regarding energy isolation and demonstrate consistent compliance with those regulations. (*)
- Describe OSHA regulations for storage, handling, and use of hazardous materials. (*)
- Demonstrate the ability to locate and use material SDSs to determine how hazardous materials should be stored, transported, and used and to explain steps one should take should there be accidental exposure to the material. (*)
- Demonstrate the ability to use appropriate equipment to extinguish fires. (*)
- Explain the steps one should take in the event of broken bones, burns or lacerations and describe how one should protect themselves and others from exposure to bloodborne pathogens. (*)
- Identify safety equipment used in mechanical engineering, such as machine guarding. (*)
- Describe and follow appropriate safety protocols when working around forklifts, trucks and other vehicles. (*)

Manufacturing Principles and Processes (*) indicates knowledge and skills listed in the SME's "Certified Manufacturing Associate Body of Knowledge"
Hours: 20–30
Sample learning objectives ▪ Describe and apply the 5 "S-principles" (sort, set in order, sweep, standardize, and sustain) to setting up, maintaining order in, and auditing the work environment. (*) ▪ Explain the key principles of lean manufacturing, including the importance of waste reduction, the concept of value-added, the relevance of push and pull systems, and the importance of continuous improvement. (*) ▪ Explain the importance of smart manufacturing and the ways that artificial intelligence, robots and other smart technologies can be used to improve manufacturing outputs, reduce costs, or improve efficiencies. ▪ Explain the purpose of additive manufacturing (AM), the materials typically used in additive manufacturing and the advantages and disadvantages of AM processes. (*) ▪ Describe and demonstrate the ability to use proper techniques to troubleshoot problems. (*) ▪ Explain and demonstrate the ability to use various methods to engage in troubleshooting and problem-solving, including check sheets, fishbone diagrams, and Pareto charts. (*) ▪ Explain and demonstrate the ability to engage in team-based troubleshooting. (*) ▪ Demonstrate the ability to properly document troubleshooting procedures. (*)

Material Science
Hours: 30–45
Sample learning objectives ▪ Describe the four main groups of materials (metals, ceramics, polymers, and composites) used in manufacturing, the advantages and disadvantages of each, and the typical types of products made from each of these groups. ▪ List the types of materials included in each of the four main groups. ▪ List and describe the various ways in which plastics, ceramics, composites, and metals are formed and molded/shaped. ▪ Describe the cost and maintenance considerations associated with the types of materials used in manufacturing. ▪ Discuss how sustainable materials can be used as alternatives to traditional materials to reduce the environmental impact of manufacturing. ▪ Determine the "all-in" environmental impact of using various materials, including the methods used for harvesting, processing, transporting, using, and disposing of different types of materials.

- Explain how axial loads, torsion, and bending are analyzed when determining whether materials or components are of adequate strength and stability.
- *Describe the types of fasteners used to combine materials and explain the advantages and disadvantages of the various types of tools used with threaded or non-threaded fasteners.

Engineering Graphics (optional)
Hours: 45
Sample learning objectives ▪ Select digital and mechanical drafting tools, procedures, and forms of graphical representation appropriate to specific needs and industry standards. ▪ Demonstrate basic drafting skills including neatness, accuracy, composition, and line weight/type. ▪ Communicate basic engineering ideas using both physical and digital drawing skills. ▪ Interpret basic engineering drawings. ▪ Explain the use of orthographic projection, auxiliary views, conventions, dimensions, tolerances, pictorial drawings, threads, and fasteners. ▪ Create two-dimensional (2D) computer drawings setting up working space (units, grids, etc.), creating and editing 2D geometries. ▪ Use industry-standard Computer Aided Design (CAD) software to model solid objects, proceeding from basic sketching techniques to the creation of solid features. ▪ Create dimensions using good dimensioning practice.

CAD/CAM Drawings in Manufacturing
Hours: 20–30
Sample learning objectives ▪ Create 2D parts views using CAD interface and basic commands. ▪ Complete 2D orthographic drawings using geometric construction and editing tools inside CAD. ▪ Properly use layers, dimensions, and notes to complete CAD drawings. ▪ Demonstrate the ability to plot properly scaled drawings. ▪ Apply parametric constraints on 2D drawings and edit to demonstrate their functional use. ▪ Create templated drawings in CAD to include section and auxiliary views. ▪ Explain the importance of proper CAD/CAM drawings to the computer numerical control (CNC) machining process.

Machining Technology (*) indicates knowledge and skills listed in the SME's "Certified Manufacturing Associate Body of Knowledge"
Hours: 30–40
Sample learning objectives ▪ Differentiate between turning, drilling, and milling and describe the different types of materials machined with each process. ▪ Explain the tools and techniques used for precision machining. ▪ Explain the purpose of tooling to create molds or casts for mass production. ▪ Explain the importance of tolerances in the manufacture of precision parts and demonstrate the ability to use appropriate tools to evaluate production quality based on prescribed tolerances. (*) ▪ Explain the purpose and types of prints used to describe component design and assembly. (*) ▪ Demonstrate the ability to read prints and complete an assembly according to print design. (*) ▪ Explain the process for using CAD designs to develop and manufacture precision parts. ▪ Explain how CNC technologies are used in modern machining and identify the major assemblies of a lathe and a mill. (*) ▪ Demonstrate the ability to use CNC technology to create a precision, machined part. ▪ Describe the basic types of industrial robotics used in machining. (*) ▪ Explain the safety risks associated with industrial robotics as well as the safeguards used to reduce risk and demonstrate the consistent use of appropriate safety protocols to ensure safety. (*)

Additive Manufacturing (AM) (*) indicates knowledge and skills listed in the SME's "Certified Manufacturing Associate Body of Knowledge"
Hours: 30–40
Sample learning objectives ▪ Describe how additive manufacturing can be used to build three-dimensional (3D) objects out of various materials. (*) ▪ Identify the types of materials that can be used in additive manufacturing, and the advantages, disadvantages, and typical uses of each. (*) ▪ Explain how AM is used to create prototypes or repair specialty components. ▪ Demonstrate the ability to set up and operate a 3D printer. ▪ Demonstrate the ability to use a CAD drawing and CNC technology to create a 3D component. ▪ Demonstrate the ability to troubleshoot 3D-printing technology.

- Explain the purpose of post-processing finishing for components made using 3D-printing technology.
- Describe the types of machines that combine additive and finishing capabilities and explain the advantages and disadvantages of using them in hybrid manufacturing.
- Name and describe the main families of additive manufacturing, including photopolymerization, power bed fusion, binder jetting, sheet lamination, material jetting, material extrusion, and directed energy deposition.

Relevant military experience

Marine Corps: MOS 13 series engineer, construction, facilities and equipment

Army: MOS 01C—mechanical engineering assistant; MOS 12 series also includes a variety of engineering technologies.

Air Force: MOS 3E series

US Navy: aviation machinist, machinist's mate

Coast Guard: machinery technicians

Diversity, equity, and inclusion

The field of mechanical engineers is predominantly made up of white (78.9 percent), males (89.9 percent), shown from the 2023 Bureau of Labor and Statistics, Household Data Annual Averages findings. Although there have been considerable efforts to diversify the engineering profession (to varying success), there has been little effort nationally to increase the number of women who work as engineering technicians. For decades, the National Science Foundation has funded efforts to recruit more women and minorities to engineering and engineering technology careers. There is only one program—the Advanced Technological Education Program—dedicated to increasing participation by women and minorities in engineering technology through grants and cooperative agreements, and only one mechanical engineering technology project has been funded so far (the US National Science Foundation). Scholarship continues to highlight opportunities for further investment to address both individual- and systems-level factors related to gender disparities in STEM. From empowering students' notions of self-efficacy to implementing better salary and leave policies, there are numerous actions that can be taken to support women and minorities in the mechanical engineering industry (Alderson et al. 2022; Chen et al. 2023; Kuchynka et al. 2023). Such investments are especially necessary given how common it is for women and people of color to leave the field due to negative experiences during their education or after entering the workforce (Fouad et al. 2017; González-Pérez et al. 2022; Silbey 2016; Ong, Jaumot-Pascual, and Ko 2020).

Works Consulted

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