



**Iowa Career and Technical Education  
Applied Sciences, Technology, Engineering and  
Manufacturing Standards**



## Industrial Technology (General Course)

1. Students will examine how engineering and technology helps improve, manage, and control natural and engineered environments.

- 1.1 Illustrate the purpose and impact of engineering and technology on society and the environment.
- 1.2 Apply the universal systems model when studying areas of applied sciences, technology engineering, and manufacturing.

2. Students will investigate the evolution of engineering, technology, and trade and industry on products, structures, and systems.

- 2.1 Analyze technological advancements throughout time periods in history.
- 2.2 Investigate inventions and innovations of products, processes, materials, and tools.
- 2.3 Evaluate how technology inventions and innovations have impacted (positive/negative) the society and the environment.

3. Students apply safety practices in the lab and on worksites.

- 3.1 Demonstrate safe practices and procedures with tools and equipment.
- 3.2 Demonstrate appropriate use of personal protective equipment
- 3.3 Document safety concerns according to local policies and procedures
- 3.4 Analyze hazardous materials procedures and OSHA.

4. Students apply and adapt appropriate workplace behaviors and characteristics to prepare for careers.

- 4.1 Demonstrate effective interpersonal, leadership and communication skills
- 4.2 Analyze education and skill requirements for engineering and technology and related professions.
- 4.3 Report the outlook, demand, and projected wages for engineering, technology, ASTEM, and trade and industry careers.
- 4.4 Research, analyze, and use data for work assignments
- 4.5 Exhibit a responsible work ethic
- 4.6 Demonstrate accepted standards for ethical behavior
- 4.7 Establish a personal career goal and develop objectives for achieving the goal
- 4.8 Create a continuing education plan that identifies further education and training options
- 4.9 Prepare for exams leading to certifications recognized by business and industry
- 4.10 Evaluate resources that keep workers current in the career field



## Automotive Technology

1. Students understand the value and necessity of practicing personal and occupational safety and protecting the environment by using materials and processes in accordance with manufacturer and industry standards.

- 1.1 Know and understand common environmental conservation practices and their applications.
- 1.2 Practice the safe handling and storage of chemicals and hazardous wastes in accordance with material safety data sheets and the requirements of local, state, and federal regulatory agencies.
- 1.3 Understand the way in which waste gasses, emissions, and other environmentally destructive substances are generated and their effects on the environment.
- 1.4 Evaluate the advantages and disadvantages of existing, new, and emerging systems and the effects of those systems on the environment.
- 1.5 Use appropriate personal protective equipment and safety practices.

2. Students understand the safe and appropriate use of tools, equipment, and work processes.

- 2.1 Understand and use appropriate tools and equipment, such as wrenches, sockets, and pliers, to maintain and repair systems and components.
- 2.2 Use tools, equipment, and machines to safely measure, test, diagnose, and analyze components and systems (e.g., electrical and electronic circuits, alternating-and direct-current applications, fluid/hydraulic and air/pneumatic systems).
- 2.3 Select and use the appropriate measurement device(s) and use mathematical functions necessary to perform required fabrication, maintenance, and operation procedures.
- 2.4 Know and understand the elements of precision measuring using standard and metric systems.
- 2.5 Use measurement scales, devices, and systems, such as dial indicators, and micrometers to design, fabricate, diagnose, maintain, and repair vehicles and components following appropriate industry standards.
- 2.6 Know and understand how to access technical reports, manuals, electronic retrieval systems, and related technical data resources.
- 2.7 Comprehend the importance of calibration processes, systems, and techniques using various measurement and testing devices.



3. Students understand scientific principles in relation to chemical, mechanical, and physical functions for various engine and vehicle systems.

- 3.1 Understand the operating principles of internal and external combustion engines.
- 3.2 Understand the function and principles of air conditioning and heating systems.
- 3.3 Understand the basic principles of pneumatic and hydraulic power and their applications.
- 3.4 Understand the applications of alternative power sources.
- 3.5 Understand the principles of converting energy from one form to another.
- 3.6 Perform necessary procedures to maintain, diagnose, service, and repair vehicle systems and malfunctions.

4. Students perform and document maintenance procedures in accordance with the recommendations of the manufacturer.

- 4.1 Understand the procedures and practices of various manufacturers regarding repair and maintenance schedules.
- 4.2 Know how to properly document maintenance procedures in accordance with applicable rules, laws, and regulations
- 4.3 Use reference books, technical service bulletins, and other documents and materials related to the automotive service industry available in print and through electronic retrieval systems to accurately diagnose and repair vehicles.
- 4.4 Complete a work order, including customer information, description of repairs, and billing information, in accordance with applicable rules, laws, and regulations.

5. Students understand the application, operation, maintenance, and diagnosis of engines, including but not limited to two- and four-stroke and supporting subsystems.

- 5.1 Perform general engine maintenance, diagnosis, service, and repair in accordance with national industry standards.
- 5.2 Maintain, diagnose, service, and repair ICE engine systems.
- 5.3 Understand how to maintain, diagnose, and repair computerized engine control systems and other engine-related systems.
- 5.4 Maintain, diagnose, service, and repair ignition, electronic, and computerized engine controls and fuel management systems.



6. Students understand the function, principles, and operation of electrical and electronic systems using manufacturer and industry standards.

- 6.1 Understand how to maintain, diagnose, and repair electrical systems.
- 6.2 Maintain, diagnose, repair, and service batteries.
- 6.3 Understand how to maintain, diagnose, service, and repair starting and charging systems.
- 6.4 Diagnose, service, and repair lighting systems.
- 6.5 Diagnose, service, and repair heating and air conditioning systems and components.
- 6.6 Diagnose, service, and repair horns, wipers/washers, and other accessories.
- 6.7 Perform necessary procedures to maintain, diagnose, service, and repair vehicle electrical and electronic systems and malfunctions.

7. Students understand the function and principles of automotive drivetrain, steering and suspension, brake, and tire and wheel components and systems in accordance with national industry standards

- 7.1 Understand how to maintain, diagnose, service, and repair hydraulic and power assist systems.
- 7.2 Diagnose, service, and repair disc brakes, drum brakes, anti-lock brakes, and other brake systems as developed.
- 7.3 Diagnose, service, and repair steering and suspension systems.
- 7.4 Understand the function and operation of automatic and manual transmissions and transaxles.
- 7.5 Maintain, service, and repair tire and wheel assemblies.
- 7.6 Maintain, diagnose, service, and repair under-vehicle systems and malfunctions.



## Automotive Collision Repair

1. Students understand the value and necessity of practicing personal and occupational safety and the environmental effects of collision repair and refinishing practices.

- 1.1 Understand industry environmental conservation practices and their applications.
- 1.2 Practice the safe handling and storage of chemicals and hazardous wastes as required by the Occupational Safety and Health Administration, Air Resources Board, Air Quality Management Districts, and other regulatory agencies.
- 1.3 Understand the generation of waste products and other environmentally destructive substances.
- 1.4 Use appropriate materials and repair technologies.
- 1.5 Understand the environmental implications of using new and emerging materials, resources, and technologies.
- 1.6 Understand the safety practices applied when servicing vehicle-body electronics and other vehicle systems.

2. Students understand the safe and appropriate use of tools, equipment, and work processes.

- 2.1 Understand how certain tools and equipment are used to perform maintenance and repair operations.
- 2.2 Use tools, equipment, and machines to safely measure, test, diagnose, and analyze components and systems (e.g., electrical and electronic circuits, alternating-and direct-current applications, fluid/hydraulic and air/pneumatic systems).

3. Students understand and apply measurement systems and the mathematical functions necessary to perform required fabrication, maintenance, and operation procedures.

- 3.1 Understand industry-standard measurement scales, devices, and systems used to perform design, fabrication, diagnostic, maintenance, and repair procedures.
- 3.2 Use technical vocabulary, technical reports and manuals, electronic systems, and related technical data resources, as appropriate, to determine repairs and estimates.
- 3.3 Understand the different types of welding and heat processes used in repair processes and procedures.
- 3.4 Understand the mathematical functions associated with collision repair and refinishing.



4. Students understand scientific principles in relation to chemical, mechanical, and physical functions and in relation to industry and manufacturer standards.

- 4.1 Understand the principles of mechanical, electrical, hydraulic, and pneumatic power in relation to collision repair and refinishing.
- 4.2 Understand the physical and chemical characteristics of metals, plastics, and other materials.
- 4.3 Understand the principles of electricity and electronics.
- 4.4 Know the basic terms, characteristics, and concepts of physical and chemical processes.
- 4.5 Understand body and frame construction.
- 4.6 Understand the importance of calibration processes, systems, and techniques in using various measurement and testing devices.

5. Students perform and document repair procedures in accordance with manufacturer recommendations and industry standards.

- 5.1 Understand the recommended procedures and practices of various manufacturers.
- 5.2 Perform and document repair procedures accurately
- 5.3 Use reference books and materials, technical service bulletins, and other related documents to determine repairs and repair time.

6. Students understand structural and nonstructural analysis and damage repair.

- 6.1 Understand how to perform frame inspection and repair.
- 6.2 Know applications, installations, and removal of fixed and moveable glass and hardware.
- 6.3 Know how to perform the principles of metal welding and cutting.
- 6.4 Understand and know how to prepare and analyze vehicles for repair.
- 6.5 Know how to perform outer body panel repairs, replacements, and adjustments.
- 6.6 Understand and know how to prepare vehicles for metal finishing and body filling.

7. Students understand mechanical and electrical components in relation to industry and manufacturer standards.

- 7.1 Understand how to perform steering and suspension analysis and repairs.
- 7.2 Know how to perform electrical repairs.
- 7.3 Know how to perform brake analysis and repairs.
- 7.4 Know how to perform heating, air conditioning, and cooling system repairs.
- 7.5 Understand the operation of drivetrain, fuel, intake, and exhaust systems.
- 7.6 Understand the operation of restraint and safety systems.



8. Students understand the concepts, principles, and practices of painting and refinishing.

- 8.1 Understand how to identify, use, and repair plastics and adhesives.
- 8.2 Know how to prepare surfaces for painting and finishing.
- 8.3 Understand the operation of spray guns and related equipment.
- 8.4 Know how to mix, match, and apply paint.
- 8.5 Understand the causes and cures of paint defects.
- 8.6 Understand how to prepare vehicles for final detail.



## Construction

1. Students understand and apply measurement systems in the planning and layout process used in the residential construction industry.

- 1.1 Identify design solutions for residential construction problems.
- 1.2 Calculate required materials for residential construction applications.
- 1.3 Convert scaled blueprint drawing measurements to full dimensions for a given construction project.
- 1.4 Apply conventional construction measurement processes accurately (geometric and trigonometric functions).
- 1.5 Know the use of conventional construction formulas to determine production requirements.

2. Students understand the safe and appropriate use of hand tools common to the residential and commercial construction industry.

- 2.1 Use the common hand tools of the trade, such as hammers, torches, pliers, wire cutters, pipe cutters, saws, chisels (wood and concrete), and wrenches, safely and properly.
- 2.2 Maintain and care for hand tools used in residential and commercial construction.

3. Students understand the safe and appropriate use of portable power tools that are common to the residential construction industry and are appropriate to the individual student's level.

- 3.1 Use portable power tools, such as circular saws, table saws, saber saws, drills, planers, and sanders, safely and properly.
- 3.2 Use portable pneumatic tools, such as rough framing nail guns, interior finishing and brad nail guns, hammers, impact wrenches, drills, and compressors, safely and appropriately.
- 3.3 Maintain and care for portable power tools and portable pneumatic tools.

4. Students understand project management procedures and processes as they occur in a construction project.

- 4.1 Interpret and use residential construction blueprints and specifications.
- 4.2 Understand how to estimate materials from blueprints and specifications.
- 4.3 Understand the sequencing of events for specific construction projects.
- 4.4 Solve common residential construction problems, such as framing, plumbing, and electrical, by using the official codes.
- 4.5 Understand industry conventions for the creation and maintenance of construction logs.
- 4.6 Understand customer service/relations as applied to project management and wholesale and retail sales.



5. Students understand the value and necessity of practicing occupational safety in the construction industry facility and job site.

- 5.1 Understand the safe use of electrical connection methods and electrical wiring procedures.
- 5.2 Know the safety procedures and practices in various work environment settings pertaining to residential and commercial construction.

6. Students understand the variety of building phases, systems, and techniques used in residential and commercial construction.

- 6.1 Develop building plans and schedules by using processes common to residential and commercial construction.
- 6.2 Understand the processes and materials (e.g., structural, electrical, mechanical, finish) appropriate to the architectural design and residential construction.
- 6.3 Prepare the site layout and the site, including the grading and engineering of the building pad.
- 6.4 Complete the phases of residential and commercial construction.

7. Students understand the impact of financial, technical, environmental, and labor trends on the past and future of the construction industry.

- 7.1 Understand significant historical trends in the construction industry.
- 7.2 Develop plans for construction projects.
- 7.3 Understand the environmental regulations that influence residential and commercial.



## Diesel Engine Technology

1. Students analyze diesel engine operations to diagnose and repair malfunctions.

- 1.1 Analyze the fundamentals of a diesel engine
- 1.2 Identify tools and equipment used in engine service
- 1.3 Utilize scan tools for engine service
- 1.4 Identify new emission controls and serviceability
- 1.5 Perform injection system repair procedures
- 1.6 Diagnose drivability concerns
- 1.7 Demonstrate proper shop safety practices while servicing engines

See Automotive Standards



## Cabinetmaking and Wood Products

1. Students understand measurement systems in the planning and layout process used in the cabinetmaking and wood products industry.

- 1.1 Know design solutions to common problems in cabinetmaking and wood products.
- 1.2 Understand calculation procedures for materials and production requirements for wood product designs.
- 1.3 Convert scaled drawing measurements to full dimensional layout and template applications.
- 1.4 Know conventional measurement processes for cabinetmaking and wood products, linear measurements, and conversions of fractions and decimals.

2. Students understand the safe and appropriate use of hand tools common to the cabinetmaking and wood products industry.

- 2.1 Use common hand tools and accessories, such as planers, shapers, clamping and gripping tools, pliers, wrenches, wood chisels, hammers, hand saws, and squares, safely and properly.
- 2.2 Maintain and care for common hand tools.

3. Students understand the safe and appropriate use of portable power tools common to the cabinetmaking and wood products industry.

- 3.1 Use portable power tools, such as single and compound miter saws, drills, sanders, saber saws, and routers, safely and appropriately.
- 3.2 Use pneumatic tools, such as pneumatic clamps, grips, framing nail guns, and finishing and brad nail guns, safely and properly.
- 3.3 Maintain and care for portable power and pneumatic tools.

4. Students understand the safe and appropriate use of stationary power machines and equipment common to the cabinetmaking and wood products industry.

- 4.1 Understand the proper and safe use of stationary power tools used in the milling process, such as shapers, sanders, joiners, table saws, and band saws.
- 4.2 Understand the proper and safe use of stationary power tools used in the assembly process, such as pneumatic table clamps, case clamps, case frame fasteners, and hardware fasteners.
- 4.3 Understand the proper and safe use of stationary power tools used in the finishing process, such as glue applicators, laminate applicators, and lacquer and paint applicators.
- 4.4 Know the basic care, maintenance, and lock-out procedures for stationary power tools.



5. Students understand the value and necessity of practicing occupational safety in the cabinetmaking/wood products industry or shop.

- 5.1 Know the safety rules in the cabinetmaking/wood products work environment.
- 5.2 Use hand tools (wood chisels, drills, coping saws) and power tools (routers, sanders, planers) safely in the cabinetmaking/ wood products work environment.
- 5.3 Understand how to handle and dispose of toxic materials safely and use protective clothing as needed when using lacquers, acetone, thinners, staining materials, and so forth in an environmentally responsible manner.

6. Students understand the variety of production processes used in the cabinetmaking and wood products industry.

- 6.1 Design and create cabinet and wood products.
- 6.2 Develop a production plan, including the layout, bill of materials, and cost analysis, for the production of cabinets or wood products.
- 6.3 Use stationary and portable power tools in milling the components for cabinets and wood products.
- 6.4 Use stationary and portable power tools in the assembly of cabinet and wood product components.
- 6.5 Use finish tools (e.g., airless sprayers, palm sanders) and techniques for finishing cabinets and wood products.
- 6.6 Use installation tools and understand the processes for the installation of cabinets, millwork, and wood products.

7. Students understand the impact of financial, technical, and environmental trends on the past and future of the cabinetmaking and wood products industry.

- 7.1 Understand significant historical trends in cabinetmaking and wood products technology.
- 7.2 Understand environmental regulations that influence the cabinetmaking and wood products industry.
- 7.3 Understand issues of the sustainable use of wood product resources.



## Drafting and Design

1. Students recognize historical and current events related to engineering design and their effects on society.

- 1.1 Know historical and current events that have relevance to engineering design.
- 1.2 Understand the development of graphical language in relation to engineering design.

2. Students understand the effective use of engineering design equipment.

- 2.1 Use the appropriate methods and techniques for employing all engineering design equipment.
- 2.2 Apply conventional engineering design processes and procedures accurately, appropriately, and safely.
- 2.3 Apply the concepts of engineering design to the tools, equipment, projects, and procedures of engineering and design projects.

3. Students understand measurement systems as they apply to engineering design.

- 3.1 Know how the various measurement systems are used in engineering drawings.
- 3.2 Understand the degree of accuracy necessary for engineering design.

4. Students use proper projection techniques to develop orthographic drawings.

- 4.1 Understand the commands and concepts necessary for producing drawings through traditional or computer-aided means.
- 4.2 Understand the orthographic projection process for developing multiview drawings.
- 4.3 Understand the various techniques for viewing objects.
- 4.4 Use the concepts of geometric construction in the development of design drawings.
- 4.5 Apply pictorial drawings derived from orthographic multiview drawings and sketches and from a solid modeler.

5. Students know various object-editing techniques and CAD programs.

- 5.1 Understand the commands and concepts necessary for editing engineering drawings.
- 5.2 Know the various object-altering techniques.
- 5.3 Know the CAD components and the operational functions of CAD systems.
- 5.4 Apply two-dimensional and three-dimensional CAD operations in creating working and pictorial drawings, notes, and notations.
- 5.5 Understand how to determine properties of drawing objects.



## 6. Students understand and apply proper dimensioning to drawings.

- 6.1 Know a variety of drafting applications and understand the proper dimensioning styles for each.
- 6.2 Apply dimensioning to various objects and features.
- 6.3 Edit a dimension by using various editing methods.

## 7. Students understand sectional view applications and functions.

- 7.1 Understand the function of sectional views.
- 7.2 Use a sectional view and appropriate cutting planes to clarify hidden features of an object.

## 8. Students understand the tolerance relationships between mating parts.

- 8.1 Understand what constitutes mating parts in engineering design.
- 8.2 Use tolerancing in an engineering drawing.
- 8.3 Interpret geometric tolerancing symbols in a drawing.

## 9. Students understand the methods of inserting text into a drawing.

- 9.1 Understand the processes of lettering and text editing.
- 9.2 Develop drawings using notes and specifications.
- 9.3 Understand the methods of title block creation.

## 10. Students understand the sketching process used in concept development.

- 10.1 Understand the process of producing proportional two- and three-dimensional sketches and designs.
- 10.2 Use sketching techniques as they apply to a variety of architectural and engineering models.
- 10.3 Use freehand graphic communication skills to represent conceptual ideas, analysis, and design concepts.



## Engineering and Design

1. Students recognize historical and current events related to engineering design and their effects on society.

- 1.1 Know historical and current events that have relevance to engineering and design.
- 1.2 Understand the development of graphical language in relation to engineering design.

2. Students understand the effective use of engineering design equipment.

- 2.1 Use the appropriate methods and techniques for employing all engineering design equipment.
- 2.2 Apply conventional engineering design processes and procedures accurately, appropriately, and safely.
- 2.3 Apply the concepts of engineering design to the tools, equipment, projects, and procedures of engineering and design projects.

3. Students understand measurement systems as they apply to engineering design.

- 3.1 Know how the various measurement systems are used in engineering drawings.
- 3.2 Understand the degree of accuracy necessary for engineering design.

4. Students understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems.

- 4.1 Know the six simple machines and their applications.
- 4.2 Know how energy is transferred; know the effects of resistance in mechanical, electrical, fluid, and thermal systems.
- 4.3 Solve problems by using the appropriate units applied in mechanical, electrical, fluid, and thermal engineering systems.

5. Students understand the design process and how to solve analysis and design problems.

- 5.1 Understand the steps in the design process.
- 5.2 Determine what information and principles are relevant to a problem and its analysis.
- 5.3 Choose between alternate solutions in solving a problem and be able to justify the choices made in determining a solution.
- 5.4 Understand the process of developing multiple details into a single solution.
- 5.5 Build a prototype from plans and test it.
- 5.6 Evaluate and redesign a prototype on the basis of collected test data.



6. Students understand industrial engineering processes, including the use of tools and equipment, methods of measurement, and quality assurance.

- 6.1 Know the common structure and processes of a quality assurance cycle.
- 6.2 Understand the major manufacturing processes.
- 6.3 Use tools, fasteners, and joining systems employed in selected engineering processes.
- 6.4 Estimate and measure the size of objects in both Standard International and United States units.
- 6.5 Calibrate and measure objects by using precision measurement tools and instruments.

7. Students understand the concepts of physics that are fundamental to engineering technology.

- 7.1 Understand Newton's laws and how they affect and define the movement of objects.
- 7.2 Understand how the laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.

8. Students understand the fundamentals of systems and products as they are developed and released to production and marketing.

- 8.1 Understand the process of product development.
- 8.2 Understand charting and the use of graphic tools in illustrating the development of a product and the processes involved.

9. Students understand the effective use of engineering technology equipment.

- 9.1 Use methods and techniques for employing all engineering technology equipment appropriately.
- 9.2 Apply conventional engineering technology processes and procedures accurately, appropriately, and safely.
- 9.3 Apply the concepts of engineering technology to the tools, equipment, projects, and procedures of the program.



## Manufacturing

1. Students understand the planning and layout operations used in machine tool and materials forming processes.

- 1.1 Interpret scaled machine tool and materials forming prints; gather design and materials information; perform calculations; and use the detail to plan, lay out, and produce parts or finished products that meet applicable standards.
- 1.2 Understand the design parameters across machine tool and materials-forming organizational levels.
- 1.3 Use current information technology ideation and design process systems in the manufacturing of machined and formed parts and products.

2. Students understand how materials can be processed through the use of machine tools, such as milling, drilling, turning, and shaping machines, and forming equipment, such as dies, presses, and rolls.

- 2.1 Understand the qualities of various raw and industrial materials and how these qualities affect the ability of the materials to be processed in the manufacturing of machined and formed parts and products.
- 2.2 Use machine tools, such as machine lathes, milling machines, drilling machines, power hacksaws, and band saws, and forming equipment, such as presses, brakes, ironworkers, and stake benches, to cut, shape, combine, and form manufactured parts or products that meet the standards of the National Institute for Metalworking Skills, the Manufacturing Skill Standards Council, or similar standards.

3. Students understand various types of machine and forming assembly processes, such as flow, pressure, cold, and adhesive bonding, and mechanical fasteners.

- 3.1 Use various methods for the assembly of machined and formed parts and products in manufacturing, such as thread cutting and bonding agents.
- 3.2 Select and use the tools, such as taps and dies, wrenches, and spot welders, and the assembly process appropriate to the design criteria of a specific machined and formed product.

4. Students understand finishing processes and the differences between various types of finishing materials used in the manufacturing of machined and formed parts and products.

- 4.1 Understand and use processes such as dipping, plating, spraying, and flow coating to finish machined and formed materials.
- 4.2 Select and use appropriate machined- and formed-part finishing processes, such as coating, plating, and anodizing, to meet specific product design criteria.



5. Students understand the purposes and processes of inspection and quality control in machining and forming manufacturing processes.

- 5.1 Know the reasons for inspection and quality control in the manufacture of machined and formed parts.
- 5.2 Know how to perform a continuous online quality control inspection of machined and formed parts.
- 5.3 Know how to troubleshoot performance problems of machining and forming systems.

6. Students understand various machining and forming manufacturing systems that require standard hand and machine tools.

- 6.1 Understand the characteristics of various machining and forming systems used in conventional manufacturing industries, such as open dies, smith forging, blow molding, stamping, drawing, shearing, chip removal, milling, turning, and electrical discharge systems.
- 6.2 Select and use appropriate machining and forming tools, equipment, and inspection devices to manufacture parts or products.

7. Students understand various machining and forming automated manufacturing systems, tool design, design for manufacturing, flexible manufacturing systems, and materials resource planning.

- 7.1 Understand materials and processes in relation to machining and forming manufacturing systems.
- 7.2 Understand the processes involved in the following machining and forming manufacturing systems: “just in time,” tool design, design for manufacturing, flexible manufacturing systems, and materials resource planning.
- 7.3 Use computers to design and produce machined and formed products, write numerical control programs, and control robots.

8. Students understand the development of emerging machining and forming technology systems.

- 8.1 Manufacture parts or products from industrial materials by using machining and forming systems, such as electrical discharge, laser cutting, chemical machining, and chemical bonding processes.
- 8.2 Understand the importance of maintaining documentation for machining and forming systems.



9. Students understand the operation and functions of machine tools in production and prototype work.

- 9.1 Use various machine tools, such as lathes, mills, drills, and saws, to produce parts and products.
- 9.2 Select appropriate machining processes and equipment to produce prototypes or production parts or products.

10. Students understand industrial forming processes and their application to specific types of materials.

- 10.1 Use various forming tools and equipment, such as rolls, brakes, dies, and presses, to manufacture parts and products.
- 10.2 Select appropriate tools, processes, and equipment to successfully produce formed parts or products.

11. Students understand how a manufacturing company is organized and the elements of a machining and forming production management system.

- 11.1 Understand corporate structures that affect machining and forming production.
- 11.2 Understand that a machining and forming production management system includes planning, engineering, organizing, and controlling resources and manufacturing processes.
- 11.3 Know how scheduling, quality control, accident prevention, and inventory control are used efficiently and appropriately in a machining and forming production management system.



## Precision Metalworking

1. Students understand the planning and layout operations used in machine tool and materials forming processes.
  - 1.1 Interpret scaled machine tool and materials forming prints; gather design and materials information; perform calculations; and use the detail to plan, lay out, and produce parts or finished products that meet applicable standards.
  - 1.2 Understand the design parameters across machine tool and materials-forming organizational levels.
  - 1.3 Use current information technology ideation and design process systems in the manufacturing of machined and formed parts and products.
2. Students understand how materials can be processed through the use of machine tools, such as milling, drilling, turning, and shaping machines, and forming equipment, such as dies, presses, and rolls.
  - 2.1 Understand the qualities of various raw and industrial materials and how these qualities affect the ability of the materials to be processed in the manufacturing of machined and formed parts and products.
  - 2.2 Use machine tools, such as machine lathes, milling machines, drilling machines, power hacksaws, and band saws, and forming equipment, such as presses, brakes, ironworkers, and stake benches, to cut, shape, combine, and form manufactured parts or products that meet the standards of the National Institute for Metalworking Skills, the Manufacturing Skill Standards Council, or similar standards.
3. Students understand various types of machine and forming assembly processes, such as flow, pressure, cold, and adhesive bonding, and mechanical fasteners.
  - 3.1 Use various methods for the assembly of machined and formed parts and products in manufacturing, such as thread cutting and bonding agents.
  - 3.2 Select and use the tools, such as taps and dies, wrenches, and spot welders, and the assembly process appropriate to the design criteria of a specific machined and formed product.
4. Students understand finishing processes and the differences between various types of finishing materials used in the manufacturing of machined and formed parts and products.
  - 4.1 Understand and use processes such as dipping, plating, spraying, and flow coating to finish machined and formed materials.
  - 4.2 Select and use appropriate machined- and formed-part finishing processes, such as coating, plating, and anodizing, to meet specific product design criteria.



5. Students understand the purposes and processes of inspection and quality control in machining and forming manufacturing processes.

- 5.1 Know the reasons for inspection and quality control in the manufacture of machined and formed parts.
- 5.2 Know how to perform a continuous online quality control inspection of machined and formed parts.
- 5.3 Know how to troubleshoot performance problems of machining and forming systems.

6. Students understand various machining and forming manufacturing systems that require standard hand and machine tools.

- 6.1 Understand the characteristics of various machining and forming systems used in conventional manufacturing industries, such as open dies, smith forging, blow molding, stamping, drawing, shearing, chip removal, milling, turning, and electrical discharge systems.
- 6.2 Select and use appropriate machining and forming tools, equipment, and inspection devices to manufacture parts or products.

7. Students understand various machining and forming automated manufacturing systems, tool design, design for manufacturing, flexible manufacturing systems, and materials resource planning.

- 7.1 Understand materials and processes in relation to machining and forming manufacturing systems.
- 7.2 Understand the processes involved in the following machining and forming manufacturing systems: “just in time,” tool design, design for manufacturing, flexible manufacturing systems, and materials resource planning.
- 7.3 Use computers to design and produce machined and formed products, write numerical control programs, and control robots.

8. Students understand the development of emerging machining and forming technology systems.

- 8.1 Manufacture parts or products from industrial materials by using machining and forming systems, such as electrical discharge, laser cutting, chemical machining, and chemical bonding processes.
- 8.2 Understand the importance of maintaining documentation for machining and forming systems.



9. Students understand the operation and functions of machine tools in production and prototype work.

- 9.1 Use various machine tools, such as lathes, mills, drills, and saws, to produce parts and products.
- 9.2 Select appropriate machining processes and equipment to produce prototypes or production parts or products.

10. Students understand industrial forming processes and their application to specific types of materials.

- 10.1 Use various forming tools and equipment, such as rolls, brakes, dies, and presses, to manufacture parts and products.
- 10.2 Select appropriate tools, processes, and equipment to successfully produce formed parts or products.



## Welding

### 1. Students understand the planning and layout operations used in welding processes.

- 1.1 Interpret scaled welding prints; gather design and materials information; perform calculations; and use the detail to plan, lay out, and produce parts or finished products.
- 1.2 Understand the design parameters across welding-process organizational levels.
- 1.3 Use current information technology ideation and design process systems in the manufacturing of welded parts and products.

### 2. Students understand how materials can be processed through the use of welding tools and equipment.

- 2.1 Understand the qualities of various raw and industrial materials and how these qualities affect the ability of the materials to be processed to produce useful and value-added welded parts and products.
- 2.2 Use welding tools and equipment, such as MIG, TIG, arc, forge and furnace, to combine or join manufactured parts and products, resulting in a finished product that meets industry standards.

### 3. Students understand various types of welding assembly processes.

- 3.1 Bond industrial materials by using adhesive and cohesive processes, such as flow, pressure, cold, and fusion bonding.
- 3.2 Understand the processes used for finishing welded materials.
- 3.3 Use welding tools, such as MIG, TIG, arc, forge, and furnace, and the equipment and assembly processes appropriate to the design criteria of a specific product to result in a finished product that meets industry standards.

### 4. Students understand finishing processes and the differences between various types of finishing materials used in the manufacture of welded parts and products.

- 4.1 Know the steps to be taken and the choices to be made in finishing welded materials.
- 4.2 Understand how to select an appropriate finishing process to meet the design criteria of a specific welded product.

### 5. Students understand the purposes and processes of inspection and quality control in welding manufacturing processes.

- 5.1 Know the reasons for inspection and quality control in the manufacturing of welded parts.
- 5.2 Perform quality control inspections of welded parts.
- 5.3 Know how to troubleshoot performance problems of welding systems.



6. Students understand various welding systems that require standard hand and machine tools.

- 6.1 Understand the various welding systems used in conventional manufacturing industries in order to select and use appropriate tools, equipment, and inspection devices.
- 6.2 Select and use appropriate welding tools, equipment, and inspection devices to manufacture parts or products.

7. Students understand various automated welding systems, welding design for manufacturing, flexible manufacturing systems, and materials resource planning.

- 7.1 Understand materials and processes in relation to welding systems.
- 7.2 Understand welding processes involved in the following manufacturing systems: “just in time,” design for manufacturing, flexible manufacturing systems, and materials resource planning.
- 7.3 Use computers to design and produce welded products, write numerical control programs, and control robots.
- 7.4 Understand the ways in which emerging welding systems may be integrated into current manufacturing processes.
- 7.5 Understand the importance of maintaining documentation for welding systems.

8. Students understand various joining or combining processes, including welding processes used in manufacturing, maintenance, and repair.

- 8.1 Know various welding processes used to complete a fabrication, an assembly, or a repair.
- 8.2 Complete a fabrication, an assembly, or a repair by using appropriate techniques and processes.

9. Students understand how a manufacturing company is organized and the elements of welding production management.

- 9.1 Understand corporate structures that affect welding production.
- 9.2 Understand that a welding production management system includes planning, engineering, organizing, and controlling resources and manufacturing processes.
- 9.3 Know how scheduling, quality control, accident prevention, and inventory control are used efficiently and appropriately in a welding production management system.