PRECISION MACHINING 48.0500.30

TECHNICAL STANDARDS

An Industry Technical Standards Validation Committee developed and validated these standards on January 30, 2020. The Arizona Career and Technical Education Quality Commission, the validating authority for the Arizona Skills Standards Assessment System, endorsed these standards on July 13, 2020.

Note: Arizona's Professional Skills are taught as an integral part of the Precision Machining program.

The Technical Skills Assessment for Precision Machining is available SY2021-2022.

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STANDARD 1.0 ANALYZE THE EVOLUTION OF PRECISION MACHINING

1.1 Explain the machining process (i.e., utilizing YouTube videos, etc.)

1.2 Discuss the history of machining

1.3 Identify the significance of machining in society

1.4 Discuss types of machine tools (e.g., sawing machines, drill press, lathe, milling, CNC mills, CNC lathes, and CAD CAM)

1.5 Discuss types of machining operations [e.g., abrasive, electrical discharge, laser, waterjet, and additive manufacturing (i.e., 3D printing, etc.)]

1.6 Identify the national standards and certifications for the industry

1.7 Discuss new advances in the industry [i.e., additive manufacturing (i.e., 3D printing, etc.), multiaxis machining, etc.]

STANDARD 2.0 APPLY INDUSTRY SAFETY STANDARDS FOR PRECISION MACHINING

2.1 Explain the purpose of the Occupational Safety and Health Administration (OSHA)

2.2 Identify Personal Protective Equipment (PPE) appropriate for working in a machining environment

2.3 Interpret basic Safety Data Sheet (SDS) information

2.4 Identify potential shop accidents and causes that lead to them

2.5 Follow shop safety rules (e.g., clothing/jewelry, PPE, and accepted behavior)

STANDARD 3.0 APPLY PRINT READING AND KNOWLEDGE AND SKILLS

3.1 Use industry language to describe prints, engineered drawings, line conventions and lettering, title blocks and parts lists, and GD&T (geometric dimension and tolerance)

3.2 Identify shapes, geometric terms and constructions, multiview drawings, section views, auxiliary views, and screw thread representation

3.3 Identify fundamentals of size descriptions (e.g., dimensioning, tolerancing, machining specifications and drawing notes, surface texture symbols, geometric dimensioning and tolerancing, classes of fit, and drawing revision systems)

3.4 Explain industrial drawing types (e.g., detailed and assembly drawings)

3.5 Describe specialized parts and prints (i.e., welding prints, precision sheet metal parts, plastic parts, springs and fasteners, gears, splines, serrations, cam diagrams, instrumentation, etc.)

STANDARD 4.0 IMPLEMENT PRECISION AND SEMI-PRECISION MEASUREMENT

4.1 Explain the purpose of quality assurance, process planning, and quality control systems in the machining industry [e.g., Statistical Process Control (SPC), and International Organization for Standardization (ISO)]

4.2 Perform machine tool math (e.g., fractional operations, fractional/decimal conversion, ratios and proportions, English/metric conversions, basic geometry, angles, Cartesian coordinates, and basic trigonometry)

4.3 Use semi-precision measurement tools (e.g., machinist's rule, combination sets, protractors, and scales)

4.4 Use precision measurement tools (e.g., gage blocks, dial calipers, sine tools, micrometers, optical comparators, dial/test indicators, and height gages)

STANDARD 5.0 DISTINGUISH AMONG TYPES OF MATERIALS AND ROUTINE MAINTENANCE REQUIREMENTS

5.1 Differentiate between ferrous and nonferrous materials

5.2 Identify national standards of materials classifications [e.g., AISI (American Iron and Steel Institute), SAE (Society of Automotive Engineers), ASTM (American Society for Testing and Materials), and UNS (Unified Numbering System)] (i.e., marking methods, identification, etc.)

5.3 Explain common heat treatment processes

5.4 Assess the importance of a routine maintenance program (e.g., lubrication methods, inspection points, and cutting fluids)

STANDARD 6.0 DESIGN AND APPLY A JOB PROCESS PLAN INCLUDING BENCHWORK, LAYOUT, AND SIMPLE MACHINING

6.1 Perform basic layout process and procedures including mathematical calculations using semi-precision and precision layout tools (i.e., material selection, tool selection, machining order of operations, use of drill and tap charts, etc.)

6.2 Demonstrate proper tool use and related safety precautions (i.e., hand drill, drill press, hammers, files, etc.)

6.3 Demonstrate safe operation of saws, cutoff machines, and drill press (e.g., safety glasses, securing workpieces, shutting off spindle, cleaning, and good housekeeping rules)

6.4 Explain the uses of offhand grinding and related safety precautions

6.5 Identify major components of a drill press and their functions

6.6 Demonstrate drilling, reaming, threading, and tapping operations

6.7 Apply proper tooling (e.g., tools, toolholding, and workholding)

STANDARD 7.0 PERFORM BASIC TURNING OPERATIONS

7.1 Identify major components of a lathe and their functions (i.e., headstock, chuck, ways, cross slide, saddle, apron, compound, etc.)

7.2 Explain safe operation of a lathe (e.g., shirts, sleeves, hair, chuck key, and chip management)

7.3 Apply proper tooling (e.g., tools, toolholding, and workholding)

7.4 Demonstrate safe operation of a lathe [e.g., cutting threads and tapers, OD (outside diameter), ID (inside diameter), chucking, between centers, facing, and grooving)]

STANDARD 8.0 PERFORM BASIC MILLING OPERATIONS

8.1 Identify major components of a vertical milling machine and their functions (i.e., quill, ram, head, knee, table, column, travel indicator dials, etc.)

8.2 Explain safe operation of a mill (e.g., shirts, sleeves, hair, and chip management)

8.3 Apply proper tooling (e.g., tramming head, indicating vice, tools, toolholding, workholding, edge finder, and indicating part features)

8.4 Explain use of accessories to increase efficiency when operating a mill (e.g., rotary table, right angle heads, and sine plates)

8.5 Demonstrate safe operation of a mill (e.g., squaring blocks, pocket milling, and boring holes)

STANDARD 9.0 EXPLAIN BASIC PRECISION GRINDING OPERATIONS

9.1 Identify types of precision grinding machines [i.e., surface grinders, cylindrical grinders, thread grinders, ID (internal diameter), OD (outside diameter), etc.]

9.2 Describe precision grinder safety guidelines (e.g., safety glasses, work shoes and clothing, machine guards and covers, locks and tags, wheels and workpieces, ring test, and blotter)

STANDARD 10.0 DESCRIBE BASIC OPERATIONS OF CNC MACHINES

10.1 Compare and contrast Cartesian and polar coordinate systems in CNC programming (e.g., X-, Y-, and Z-axis, primary axis, and secondary axis)

10.2 Describe absolute and incremental positioning systems

10.3 Describe the purpose of codes and commands (e.g., G-codes, M-codes, S-commands, and F-commands)

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10.4 Identify types of machine controls (i.e., Fanuc, Haas, Mazak, Mitsubishi, Siemens, etc.)

10.5 Identify types of CNC machines (i.e., CNC Lathe, CNC Mill, EDM, laser, waterjet, part marker, etc.)

STANDARD 11.0 PERFORM BASIC CNC TURNING OPERATIONS

11.1 Identify parts of CNC turning machines (i.e., chuck, spindle, turret, tailstock, steady rest, control, bar feeder/puller, machine guards, etc.)

11.2 Describe the X- and Z-axis used for turning (i.e., live tooling, multi-axis, etc.)

11.3 Apply turning programming codes (e.g., G- and M-code programming, cutter compensation, calculating feeds and speeds)

11.4 Apply CNC-specific turning operations and canned cycles (e.g., roughing/finishing turning cycles, drilling, and tapping cycles)

11.5 Perform basic set-up procedures (e.g., workholding, offsets, proper use of toolholders, and indicating drills and reamers)

11.6 Demonstrate program prove-out procedures (e.g., single block, rapid points, shadow paths, graphics, position screen, and selecting and loading programs)

11.7 Perform maintenance program (e.g., maintain machine maintenance log sheets, inspection points, and cutting fluids)

STANDARD 12.0 PERFORM BASIC CNC MILLING OPERATIONS

12.1 Identify parts of CNC milling machines (i.e., spindle, ATC, table, way covers, chip conveyer, controller, machine guards, etc.)

12.2 Describe the X-, Y-, and Z-axis used for milling (i.e., 4/5-axis, A-axis, B-axis, C-axis, etc.)

12.3 Apply milling programming codes (e.g., G- and M-code programming, cutter compensation, and calculating feeds and speeds)

12.4 Apply CNC-specific milling operations and canned cycles (e.g., drilling, tapping, and boring cycles)

12.5 Perform basic set-up procedures (e.g., workholding, offsets, and proper use of toolholders)

12.6 Demonstrate program prove-out procedures (e.g., single block, rapid points, shadow paths, graphics, position screen, and selecting and loading programs)

12.7 Perform maintenance program (e.g., maintain machine maintenance log sheets, inspection points, and cutting fluids)

STANDARD 13.0 DESCRIBE ADVANTAGES OF USING COMPUTER AIDED-DESIGN (CAD) AND COMPUTER-AIDED MANUFACTURING (CAM) SOFTWARE

13.1 Describe basic applications of CAD and CAM

13.2 Explain the use of drawings (e.g., wireframe, solid model, and surface)

13.3 Describe the process of toolpath creation and toolpath types

13.4 Explain basic principles of post-processing

STANDARD 14.0 PERFORM BASIC USE OF COMPUTER AIDED-DESIGN (CAD) AND COMPUTER-AIDED MANUFACTURING (CAM) SOFTWARE

14.1 Perform basic applications of CAD and CAM (e.g., use of sketch tools, planes, coordinate systems, wireframe and solid creation, and different file extensions)

14.2 Use drawing tools to create wireframe, solid models, and surfaces

14.3 Apply toolpaths to solid model or wireframe; verify/backplot toolpaths through simulation

14.4 Use post processor to generate and evaluate G-code

14.5 Generate tool lists, setup sheets, and file saving through CAM software

STANDARD 15.0 PERFORM ADDITIVE MANUFACTURING WITH CAD

15.1 Explain principles of 3D printers, materials, and applications, legal aspects, health and safety, and impact

15.2 Create, design, and make complex shapes, geometrics, and solid models with CAD

15.3 Save file types (e.g., STL and WRL)

15.4 Use 3D printing software to define part program characteristics (i.e., raft, infill, part orientation, support material, tolerance, etc.) and generate code

15.5 Set up machinery and print the part

15.6 Use post-manufacturing process for finished 3D printed models

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