MECHANICAL DRAFTING 15.1306.00
TECHNICAL STANDARDS

The Mechanical Drafting program has been recognized by the Arizona State Board of Career and Technical Education (CTE) is eligible for consideration by local governing boards to grant 1 credit of 4th-year high school math. This document is the result of a committee analysis completed in 2021.

Note: AZ High School Math Standards are highlighted in yellow.

STANDARD 1.0 APPLY MEASUREMENT AND SCALE CONCEPTS IN DESIGN DRAFTING

1.1 Identify types of unit systems used in design drafting (i.e., SI units, Imperial, ANSI, IEC standards, etc.)

Quantitative Reasoning QR.NR.3 Understand and compare magnitudes of numbers utilizing real-world context. Understand the importance and impact of unit selection.
Rationale: Perform conversions and measurements using ANSI and ISO standards. Apply basic mathematical/analytical concepts and operations required for problem-solving, decision-making, economic productivity, and real-world applications

1.2 Demonstrate the use of different measurement systems (i.e., SI units, Imperial, etc.)

1.3 Explain the use of measurement tools (i.e., ruler, protractor, measuring tape, calipers, etc.)

1.4 Use types of geometric measurements (i.e., linear, angular, etc.)

1.5 Determine and apply appropriate scale

Quantitative Reasoning QR.NR.1 Represent quantities, using equivalent forms when appropriate, to investigate and describe quantitative and geometric relationships and solve problems in real-world contexts.
Quantitative Reasoning QR.CR.2 Compare, reason and communicate about proportional and nonproportional models utilizing real-world contexts.
Rationale: Scale drawings to fit within border -total length and segments with proportional relationships.

STANDARD 2.0 INTERPRET MECHANICAL DESIGN DOCUMENTS

2.1 Differentiate among mechanical, civil, and architectural drawings

2.2 Interpret dimensions, symbols, legends, and scales (i.e., diameter, depth, tolerance, parallelism, angularity, etc.)

2.3 Describe mechanical features in technical drawings (i.e., hole diameter, dimension, location, etc.)

2.4 Analyze technical drawings for clarity, completeness, and accuracy (i.e., ASME GD&T Standard, etc.)

Quantitative Reasoning QR.NR.4 Use and justify estimation skills, and know why, how, and when to estimate results. Assess and justify the reasonableness of estimations using the context and comparisons to other known values.
Rationale: Use precision, polar coordinates to analyze results

STANDARD 3.0 APPLY BEST PRACTICES TO CREATE TECHNICAL DRAWINGS

3.1 Use basic drafting techniques for drawings (i.e., isometric, oblique, projection drawing views, etc.)

Geometry G.G.GCO.A.5 Given a geometric figure and a rotation, reflection, or translation draw the transformed figure. Specify a sequence of transformations that will carry a given figure onto another.
Geometry G.G.GMD.B.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
Geometry G.G.MG.A.3 Apply geometric methods to solve design problems utilizing real-world context.
Rationale: Determine geometric measurements and methods including transformations in a plane.

Solve for missing dimensions on CAD drawings where each component is drawn and assembled together using geometry. Draw a transformed object with rotations.

3.2 Develop manual sketches that accurately reflect real objects

Geometry G.G-MG.A.1 Use geometric shapes, their measures, and their properties to describe objects utilizing real-world context
Rationale: Convert drawings to 3D with an understanding of the planes, features of quadrilaterals, and Scaling.

3.3 Communicate concepts with manual sketches

3.4 Create computer draft of sketches

Geometry G.G.GCO.A.5 Given a geometric figure and a rotation, reflection, or translation draw the transformed figure. Specify a sequence of transformations that will carry a given figure onto another.
Geometry G.G.GMD.B.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
Geometry G.G.MG.A.3 Apply geometric methods to solve design problems utilizing real-world context.
Rationale: Visualize relationships between two-dimensional and three-dimensional objects. Explain volume formulas and use them to solve problems. Apply geometric concepts in modeling situations to make geometric connections. Experiment with transformations in the plane. Understand congruence in terms of rigid motions and geometric theorems.

3.5 Classify line type and line weight

3.6 Create and identify elements of title blocks and borders

3.7 Apply notes and dimensions

3.8 Determine correct drawing scale and layout based on output requirements (e.g., hard copy and electronic delivery)

Quantitative Reasoning QR.NR.3 Understand and compare magnitudes of numbers utilizing real-world context. Understand the importance and impact of unit selection.

Rationale: Apply basic mathematical/analytical concepts and operations required for problem-solving, decision-making, economic productivity, and real-world applications.

3.9 Organize and maintain drawings and supporting documents

3.10 Prepare detail and assembly drawings

STANDARD 4.0 UTILIZE HARDWARE AND SOFTWARE TOOLS

4.1 Describe the role of new technologies in the use of drafting drawings (i.e., simulations, AI, robotics, etc.)

4.2 Use computer hardware and input/output devices for design drafting problems (i.e., 3D printers, CNC Machines, etc.)

4.3 Apply file and disk management techniques (i.e., network, revision control, document management, nomenclature for file naming, etc.)

4.4 Import and export data files using different formats (i.e., DWG, DXF, PDF, STEP, etc.)

STANDARD 5.0 APPLY CADD SYSTEM AND PROCEDURES

5.1 Explore and determine applicability of CADD

5.2 Use CADD software to set up drawing (e.g., scale, format, and dimensioning)

Geometry G.G.GCO.A.5 Given a geometric figure and a rotation, reflection, or translation draw the transformed figure. Specify a sequence of transformations that will carry a given figure onto another.
Geometry G.G.GMD.B.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
Geometry G.G.MG.A.3 Apply geometric methods to solve design problems utilizing real-world context.
Rationale: Apply geometric measurements and methods to prove geometric theorems. Model transformations in a plane to make geometric constructions. Experiment with transformations and demonstrate an understanding of congruence in terms of rigid motions.

5.3 Determine and apply CADD commands and techniques (e.g., layers, colors, line types, editing commands, and properties)

5.4 Employ available libraries and templates

5.5 Draw geometric constructions using snap functions (i.e., parallel lines, polygons, tangents, perpendicular, landscape, etc.)

Geometry G.G-CO.A.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
Geometry G.G-CO.D.12 Make formal geometric constructions with a variety of tools and methods. Constructions include: copying segments; copying angles; bisecting segments; bisecting angles; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.
Geometry G.G-CO.D.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle; with a variety of tools and methods.
Rationale: Make geometric constructions using snap function to make triangles and inscribing in a circle. Experiment with transformations in the plane. Understand congruence in terms of rigid motions. Prove geometric theorems.

5.6 Determine views for projection (e.g., plan, top, and front)

5.7 Identify, create, and place views for orthographic features

5.8 Identify, create, and place auxiliary views to determine true size, shape, and location of non-orthogonal features

Geometry G.G-GMD.B.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
Rationale: Analyze geometric dimensions and tolerances. Determine full sections and half sections.

5.9 Identify, create, and place appropriate section views

5.10 Construct full, half, offset, aligned, revolved, and removed section views

5.11 Utilize various material hatch patterns in section views

5.12 Draft assemblies, intersections, developments, and patterns (i.e., including radial and parallel line patterns)

STANDARD 6.0 COMPARE BASIC MANUFACTURING PROCESSES

6.1 Identify types of parts to be detailed (i.e., cast, machined, forged, sheet metal, welded, etc.)

6.2 Incorporate manufacturing process symbols in mechanical drawings (e.g., welding, machining, casting, and sheet metal)

6.3 Identify fasteners used in manufacturing processes (i.e., screw heads, rivets, studs, etc.)

6.4 Read a material specification sheet (i.e., mechanical material, yield strength, etc.)

6.5 Generate a bill of materials

6.6 Identify differences in material types and conditions (i.e., stainless steels, carbon steels, aluminum, plastics, etc.)

6.7 Explain dimensional tolerances of various manufacturing materials and processes (i.e., sheet metal, fabrication welding, etc.)

6.8 Identify part finishes (i.e., painted, powder coated, galvanized, anodized, etc.)

6.9 Analyze dimensional tolerance stack-up in assemblies per material/design feature

6.10 Determine the tolerance usage per material/design feature

STANDARD 7.0 APPLY DIMENSIONING BEST PRACTICES

7.1 Use dimensioning rules in compliance with ASME Y14 standards

7.2 Draw/select appropriate dimensioning practices (i.e., conventional, tabular, datum, ordinate, aligned, coordinate systems, fit, unilateral/bilateral tolerance, etc.)

7.3 Identify potential machining datums (i.e., holes, planes, circular, etc.)

7.4 Check drawings for accuracy, completeness, and clarity