

Mechanical Design 1

Exam Information	Description
Exam number 661 Items 56 National Career Cluster Advanced Manufacturing Certification available Yes	The Mechanical Design 1 industry certification exam is the first in a sequence that assesses learners' ability to plan and prepare scale, isometric drawings, and technical documentation of engineering and design concepts. This includes standard engineering practices in design and graphics, as well as the use and application of computer software to create and modify designs. Please make sure candidates have access to CAD software while taking this certification.

Exam Blueprint and Performance Skills

Standard	Percentage of exam score
1. Engineering & Design Careers*	1%
2. Sketching & the Engineering Design Process*	7%
3. Mathematics, Measuring Conventions, and Scale*	19%
4. Orthographic Views*	19%
5. Line Types*	13%
6. Dimensioning*	16%
7. CAD Software*	24%

*Includes performance skill evaluation

Standard 1 - Engineering & Design Careers (1% of exam score)

Objective 1 Explore the design aspect of the following career areas:

1. Industrial Designer
 - a. Industrial designers combine art, business, and engineering to develop the concepts for manufactured products. (U.S Bureau of Labor Statistics)
2. Mechanical Engineering
 - a. Mechanical engineers design, develop, build, and test mechanical and thermal sensors and devices. (U.S. Bureau of Labor Statistics)
3. Manufacturing/Industrial Engineering
 - a. Industrial engineers devise efficient systems that integrate workers, machines, materials, information, and energy to make a product or provide a service. (U.S. Bureau of Labor Statistics)
4. Technician

Objective 2 Understand the education and training needed for each of the occupations discussed in Objective 1.

Objective 3 Identify which post-secondary institutions, local and statewide, offer certificates and degrees related to engineering, drafting, and design.

Optional: Standard performance evaluations on the final page of this document

Standard 2 - Sketching & the Engineering Design Process (7%)

Objective 1 Engineering Design Process

1. Identify and define the design problem.
2. Brainstorm solutions
3. Create models and build a prototype.
4. Test the prototype.
5. Redesign and optimize.

Objective 2 Create accurately proportioned sketches using correct drawing conventions.

1. Demonstrate understanding of dimensioning practices and apply them to technical or design sketches.
2. Create freehand sketches using paper, pencil, and an eraser which is neat, clear, and smudge-free.
3. Create drawings or sketches with isometric, orthogonal, sections, and assembly views.
4. Understand and demonstrate the proper use of the alphabet of lines.
5. Create letters and numerals that conform to an industry-accepted style including size, spacing, pitch, and all other common factors as specified in current industry standards.
6. Create notes that are neat and legible.

Optional: Standard performance evaluations on the final page of this document

Standard 3 - Mathematics, Measuring Conventions, and Scale (19%)

Objective 1 Perform basic arithmetic functions using fractions and decimals.

1. Add
2. Subtract
3. Multiply
4. Divide

Objective 2 Convert between fractions and decimals.

Objective 3 Convert between and within metric and imperial units.

Objective 4 Make and record basic measurements.

1. Understand and demonstrate the conversion of actual lengths to common technical drawing scales.
2. Accurately set the drawing scale using CAD software when creating a drawing.
3. Record measurements using Cartesian and polar coordinates, as well as absolute and relative distances.
4. Can accurately measure to 1/16" using a ruler or tape measure.
5. Can accurately measure to a millimeter using a ruler or tape measure

Optional: Standard performance evaluations on the final page of this document

Standard 4 - Orthographic Views (19%)

Objective 1 Drawing orthographic projections.

1. Apply correct 2D geometric construction techniques.
2. Drawing elements are accurate and drawn to scale.
3. Draw on the correct plane.
4. The top, front, and side views are used unless otherwise required using orthographic projection.
 - a. Minimum number of views necessary.
5. All views are properly aligned and use third-angle projection.
6. Appropriate lines and surfaces are located on each view.

Objective 2 Understand common terminology associated with drafting and design.

1. Axis
2. Concentric

3. Diameter
4. Coordinate
5. Fillet
6. Vertical
7. Horizontal
8. Orthographic view
9. Parallel
10. Perpendicular
11. Plane
12. Radius
13. Round
14. Sketch
15. Tangent
16. Third angle projection

Optional: Standard performance evaluations on the final page of this document

Standard 5 - Line Types (13%)

Objective 1 Know common line thicknesses: .

1. Thick - 0.7mm
2. Medium - 0.5mm
3. Thin - 0.35mm
4. Thinnest - 0.25mm

Objective 2 Understand the Alphabet of lines

1. Object line
2. Hidden line
3. Cutting Plane line
4. Center line
5. Dimension line
6. Extension line
7. Leader line
8. Border line
9. Phantom line
10. Section line
11. Construction line

Objective 3 Understand Line Thickness Applications:

1. Thick Lines
 - a. Object/visible line
 - b. Cutting plane line
2. Medium Lines
 - a. Hidden line
3. Thin Lines
 - a. Center line
 - b. Section line

- c. Dimension line
- d. Leader line
- e. Extension line
- f. Phantom line

Optional: Standard performance evaluations on the final page of this document

Standard 6 - Dimensioning (16%)

Objective 1 Know proper location for dimensions.

1. Locate dimensions on the profile view and between views.
2. Apply appropriate spacing between the object and the first dimension.
3. Apply uniform spacing between dimension lines.
4. Use correct dimension line terminators such as arrowheads, ticks, and dots.

Objective 2 Compare Baseline vs. Chain dimensioning.

Objective 3 Understand leaders and notes.

1. Understand and correctly form callouts for thru holes, countersinks, counterbores, and spotfaces.
2. Demonstrate correct dimensioning for fillets, and rounds.
3. Understand and correctly form callouts for threaded holes.
4. Use appropriate angles for leaders.

Optional: Standard performance evaluations on the final page of this document

Standard 7 - CAD Software (24%)

Objective 1 Know how to do the following file operations:

1. Save
2. Open
3. Rename
4. Move

Objective 2 Create technical drawings using design software features.

1. Create a new drawing setup to support both English and metric drawing standards. Create drawing setups for different sizes of drawing sheets.
2. Use and control accuracy enhancement tools.
3. Using snap, grid and positioning methods.
4. Analyze drawings using the software features.
5. X,Y coordinates, area, distance, perimeter, etc.

Objective 3 Prepare and understand proper title blocks.

Objective 4 Add correct annotation to drawings.

1. Use the correct text height.
 - a. $\frac{1}{8}$ " (.125")
 - b. 3mm
2. Use accepted industry standards for letters and numerals.
3. Understand the placement and use of general notes.

Objective 5 Plot/print drawings with correct line widths and line types.

Optional: Standard performance evaluations on the final page of this document

Technology & Engineering Workplace Skills

1. Exceed the established school attendance policy to establish a consistent record of punctuality and dependability.
2. Appropriately use (or not use) personal electronic devices.
 - a. Maintain a high standard of industrial hygiene by:
 - b. adopting strong habits of professional dress and personal hygiene,
 - c. wearing the appropriate personal protective equipment,
 - d. adopting the habit to “clean as you go”, and
 - e. guarding against foreign object debris (FOD) from contaminating the workspace or product.
3. Contribute to a culture of safety by:
 - a. understanding and complying with established safety procedures,
 - b. watching for and speaking out when potential hazards and concerns are observed, and actively participating in improving safety conditions.
4. Follow established practices and procedures with exactness.
5. Work productively as a member of a team with an awareness of and respect for global diversity and cultural differences.
6. Exhibit initiative and leadership while maintaining a flexible and adaptable attitude.
7. Communicate clearly & effectively with others.
8. Proficiently use software found in the professional environment, such as MS PowerPoint, MS Excel, and MS Word.
9. Correctly apply mathematics in areas such as:
 - a. addition, subtraction, multiplication, division,
 - b. fraction to decimal as well as decimal to fraction conversions, and
 - c. using decimal places.
10. Understand mathematical concepts such as:
 - a. ratios and proportions,
 - b. rounding and tolerance ranges,
 - c. engineering notation, and
 - d. metric equivalents.
11. Demonstrate an ability to think critically and creatively to solve problems and develop improvements to products and processes.
12. Read and understand technical documents, such as work orders, specifications, and standard operating procedures.
13. Complete assigned tasks in a timely manner and with a high degree of workmanship

Performance Skills Evaluation

Exam name: Mechanical Design 1

Candidate Name: _____

Performance assessments may be completed and evaluated any time before the certification is issued. The following performance skills can be used in connection with the associated standards and exam. The evaluator will function as the subject matter expert to determine if the candidate meets the skills requirements with a Yes/No for passing.

Standard 1 – Engineering & Design Careers Candidates can create a personal plan to become a technician, designer, and/or engineer in your state.	Pass:
Standard 2 – Sketching and the Engineering Design Process Candidates can document their design process using sketches with correct drawing conventions.	Pass:
Standard 3 – Mathematics, Measuring Conventions, and Scale - Candidates can accurately measure to 1/16" and to a millimeter. - Candidates can add, subtract, multiply, divide, and convert in fractions and decimal units. Candidates can convert between and within metric and imperial units.	Pass:
Standard 4 – Orthographic Views Candidates can create a multiview or orthographic projection of a part.	Pass:
Standard 5 – Line Types Candidates can correctly use the alphabet of lines in a technical drawing.	Pass:
Standard 6 – Dimensioning Candidates can properly dimension a drawing.	Pass:
Standard 7 – CAD Software Candidates can create a multiview or orthographic projection of a part.	Pass:

Evaluator Name: _____

Date: _____