Connecticut Technical Education
and Career System

Mechanical Design & Engineering Technology

Curriculum Guide

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CTECS - Vision of a Graduate

Connecticut Technical Education and Career System
Vision of a Graduate

A CTECS Graduate is…

A Problem Solver

Respectful

A Critical Thinker

Work Ready

Skilled Socially

An Effective Communicator

The Vision of a Graduate (VoG) at the Connecticut Technical Education and Career System (CTECS) embodies our commitment to preparing students for success in Connecticut's workforce.

Developed in collaboration with students, parents, staff, and employers, the VoG ensures that CTECS students are not only job-ready but also equipped to lead, innovate, and adapt in a dynamic world.

As educators, we are dedicated to developing these qualities by providing a comprehensive education that empowers our students to achieve their fullest potential and make meaningful contributions to society.

A Problem Solver	Work Ready
Problem solvers tackle challenges by identifying root causes of issues, brainstorming solutions, implementing effective strategies, and demonstrating adaptability: ➔ Engage students with open-ended, creative thinking tasks that require both conventional and innovative solutions ➔ Facilitate group discussions and collaborative projects ➔ Use real-world scenarios and hands-on activities ➔ Highlight the importance of effort, persistence, and continuous learning ➔ Provide regular feedback and encourage reflection	*To be work-ready includes a combination of technical expertise, soft skills, and personal qualities that ensure a graduate can effectively contribute to the workplace from day one:* ➔ Set high standards for punctuality, responsibility, professionalism, and task completion ➔ Use project-based learning and collaborative assignments ➔ Emphasize clear written and verbal communication ➔ Offer practical exercises like mock interviews and resume workshops ➔ Integrate technology and teach digital literacy

Respectful

Graduates who embody respectfulness emphasize the importance of treating others with dignity, valuing diversity, and fostering an inclusive and positive environment, both personally and professionally:

- ➔ Demonstrate personal, interpersonal, and professional skills
- ➔ Show respect for diversity
- ➔ Model respect through active listening and empathy
- ➔ Set clear expectations for respectful interactions
- ➔ Promote collaboration and group discussions
- ➔ Celebrate respectful behavior
- ➔ Address disrespect promptly and constructively

Skilled Socially

Graduates who are skilled socially are equipped to navigate social environments, build relationships, and contribute positively to their communities and workplaces:

- ➔ Show awareness of global responsibility to others and the environment
- ➔ Participate in community involvement
- ➔ Design cooperative group projects and team activities
- ➔ Set expectations for respect and give regular feedback
- ➔ Facilitate discussions on inclusivity, kindness, and respect
- ➔ Model positive interactions and recognize strong social skills

A Critical Thinker

Critical thinkers approach problems systematically by analyzing, evaluating, and synthesizing information to make well-informed decisions and contribute to innovative solutions:

- ➔ Encourage critical thinking individually and collaboratively
- ➔ Design lessons that challenge assumptions and explore diverse viewpoints
- ➔ Use open-ended questions, rigorous activities, and cross-curricular projects
- ➔ Integrate project-based learning and real-world problem-solving
- ➔ Offer reflective opportunities like journaling and discussions
- ➔ Cultivate an environment that values curiosity and inquiry

An Effective Communicator

Effective communicators convey ideas, information, and emotions accurately and persuasively, fostering understanding and collaboration:

- ➔ Communicate effectively using oral, written, visual, artistic, and technical modes
- ➔ Include group discussions, presentations, and peer reviews
- ➔ Promote active listening and thoughtful responses
- ➔ Offer clear guidelines and constructive feedback
- ➔ Stress clear, respectful, and purposeful communication

CTECS Instructional Model

CTECS uses the Marzano Compendium to guide research-based instructional strategies that differentiate learning and promote access, engagement, and success for all students. Teachers apply these strategies to support diverse learners (including multilingual learners, students with disabilities, and students with varied academic or technical backgrounds) through scaffolds, modeling, guided practice, and multiple ways to participate and show understanding. This approach ensures every student can work toward proficiency in the Priority Standards and the competencies outlined in the CTECS Vision of a Graduate.

Marzano Compendium

Feedback

Providing and Communicating Clear Learning Goals

1. Providing scales and rubrics
2. Tracking student progress
3. Celebrating success

Using Assessments

4. Using informal assessments of the whole class
5. Using formal assessments of individual students

Content

Conducting Direct Instruction Lessons

6. Chunking content
7. Processing content
8. Recording and representing content

Conducting Practicing and Deepening Lessons

9. Using structured practice sessions
10. Examining similarities and differences
11. Examining errors in reasoning

Conducting Knowledge Application Lessons

12. Engaging students in cognitively complex tasks
13. Providing resources and guidance
14. Generating and defending claims

Using Strategies That Appear in All Types of Lessons

15. Previewing strategies
16. Highlighting critical information
17. Reviewing content
18. Revising knowledge
19. Reflecting on learning
20. Assigning purposeful homework
21. Elaborating on information
22. Organizing students to interact

Context

Using Engagement Strategies

23. Noticing and reacting when students are not engaged
24. Increasing response rates
25. Using physical movement
26. Maintaining a lively pace
27. Demonstrating intensity and enthusiasm
28. Presenting unusual information
29. Using friendly controversy
30. Using academic games
31. Providing opportunities for students to talk about themselves
32. Motivating and inspiring students

Implementing Rules and Procedures

33. Establishing rules and procedures
34. Organizing the physical layout of the classroom
35. Demonstrating withitness
36. Acknowledging adherence to rules and procedures
37. Acknowledging lack of adherence to rules and procedures

Building Relationships

38. Using verbal and nonverbal behaviors that indicate affection for students
39. Understanding students' backgrounds and interests
40. Displaying objectivity and control

Communicating High Expectations

41. Demonstrating value and respect for reluctant learners
42. Asking in-depth questions of reluctant learners
43. Probing incorrect answers with reluctant learner

Curriculum Introduction

This curriculum document outlines the essential learning for this trade program and provides a clear structure for planning, instruction, and assessment. It includes the components required by NEASC Standard 2.2a, along with elements that reflect the unique nature of CTECS technical programs. The curriculum is organized to show what students learn in each course, how learning progresses across grade levels, and how instruction supports both technical skill development and the CTECS Vision of a Graduate.

Teachers should use this document to:

- Understand the overall structure and expectations of the course sequence
- Reference the Course Map to see the scope and sequence of Priority Standards and the alignment to District Summative Assessments (DSAs)
- Use the Priority Standards and Units of Study to guide daily, weekly, and cycle-based planning
- Integrate Big Ideas, Essential Questions, Skills/Learning Outcomes, vocabulary, and resources during lesson design
- Identify required safety, industry, and technical content expectations
- Plan and implement formative assessments to monitor progress and guide instruction
- Prepare students for the District Summative Assessments, ensuring alignment with the Course Map
- Maintain consistency of technical and professional practice instruction across campuses while adapting to student needs and industry-based opportunities

Curriculum Components

Course Map

A Course Map serves as the scope and sequence for this course by outlining the progression of instructional units and the standards that guide teaching and assessment. While each campus will have individual student needs, cycle schedules, and industry-based opportunities, all instructors are expected to teach the standards outlined in the Course Map. Using the Course Map below, teachers will intentionally plan learning experiences that prepare students to meet the identified standards within the designated assessment windows.

Priority Standards (Units of Study)

Priority Standards identify the most essential learning in the trade program. They reflect the core technical competencies, safety practices, and industry-aligned skills that require the greatest instructional focus and appear on program assessments. In CTE programs, each Priority Standard also functions as a Unit of Study, because it includes the required components such as big ideas, essential questions, content topics, and skills/learning outcomes aligned to assessments.

Vertical Alignment

Vertical alignment shows how Priority Standards and instructional expectations progress from grade to grade within the trade program. It provides a clear pathway of skill development, increasing complexity, and technical proficiency across the four-year sequence.

Learning Outcomes

Learning outcomes are what students will know (Concepts) and be able to do (Skills). Concepts identify the major content topics within the Priority Standard (Unit of Study). They appear in the left column of the Learning Outcomes table and follow a similar coding structure as the Priority Standard.

Skills are learning objectives that describe the measurable actions students must be able to perform to demonstrate proficiency. They appear in the right column of the Learning Outcomes table and show the progression of learning evidence in the Priority Standard.

Vocabulary

Essential vocabulary includes the technical and academic terms students must understand and use accurately to engage in trade-specific learning and demonstrate proficiency on assessments. Vocabulary is foundational to safety, technical precision, and industry communication, and should be a primary initial focus within each unit and taught explicitly through modeling, demonstration, and repeated application.

Resources

Resources include the tools, equipment, texts, materials, and digital tools that support learning within each unit and reflect industry standards.

Assessment Practices

Teachers use ongoing formative assessments—such as questioning, checks for understanding, performance demonstrations, reflections, and teacher observation—to monitor progress, guide instruction, and support all learners in mastering the Priority Standards.

Each program also includes District Summative Assessments (DSAs), which measure proficiency on the Priority Standards identified in the Course Map. DSAs provide consistent evidence of student learning across campuses and ensure alignment to industry expectations, safety requirements, and program outcomes. Teachers should reference the Course Map and Units of Study when planning instruction to ensure students have opportunities to practice and demonstrate the skills and knowledge assessed on the DSA.

Mechanical Design and Engineering Technology Philosophy

The Mechanical Design and Engineering course of study is designed to help students develop an appreciation for the engineering, manufacturing, and mechanical systems industry while building the entry-level skills required for success in technical and engineering-related fields. Students will gain technical, academic, and professional skills that support both personal problem-solving and a successful transition from school to employment, apprenticeships, or post-secondary engineering and technology programs.

The Mechanical Design and Engineering program provides foundational engineering theory and applied technical content aligned to industry expectations. Students gain practical experience through hands-on learning in the engineering lab and fabrication shop, participation in design-build and prototype development projects, and optional Work-Based Learning placements with manufacturing, engineering, or technology-focused industry partners. These experiences allow students to apply the engineering design process in authentic settings and prepare them for continued growth within mechanical, manufacturing, and engineering career pathways.

MDET – Course Map

Grade 9 – Semester 1 & 2 DSA

- **9.1** Workplace Safety
- **9.2** Career Opportunities
- **9.3** Basic Drafting Equipment
- **9.4** Sketching & Lettering
- **9.5** Basic Geometric Construction
- **9.6** Basic Orthographic Projection
- **9.7** Basic Pictorial Drawings

Grade 10 – Semester 1 DSA

- **10.1** Workplace Safety (OSHA 10)
- **10.2** Intermediate Orthographic Drawing
- **10.3** Apply Basic Dimensioning Practices to Working Drawings
- **10.4** Practice Basic Product Data Management (PDM)

Grade 10 – Semester 2 DSA

- **10.5** Create Section View Drawings
- **10.6** Create Auxiliary View Drawings
- **10.7** Create Development Drawings
- **10.8** Understand & Apply Common Threads & Fasteners to an Engineering Drawing

Grade 11 – Semester 1 DSA

- **11.1** Demonstrate Workplace Safety
- **11.2** Create Set of Mechanical Working Drawings
- **11.3** Construct Working Drawings Utilizing 3D Solid Modeling Software
- **11.4** Apply Tolerances to Mating Parts on Working Drawings

Grade 11 – Semester 2 DSA

- **11.5** Identify & Explain Common Manufacturing Processes & Materials
- **11.6** Implement PDM/Revision Control on Working Drawings
- **11.7** Implement Good Design Practices & Principles
- **11.8** Understand Basic Lean Manufacturing Principles & Concepts

Grade 12 – Semester 1 DSA

- **12.1** Demonstrate Workplace Safety
- **12.2** Apply Advanced Dimensioning Practices GD&T
- **12.3** Complete Project Based Engineering Design Project

Grade 12 – Semester 2 DSA

- **12.3** Complete Project Based Engineering Design Project-Continued from Semester 1
- **12.4** Create Gear & Cam Mechanism Drawings

9th Grade Curriculum

Priority Standard 9.1 - Workplace Safety

Big Idea(s):

- Safety needs to be a habit and a consideration throughout daily living as well as in the work environment
- Training and awareness can prevent injuries
- Each person is responsible for following safety procedures

Essential Question:

Explain the procedures for various emergency evacuation plans.

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
9.1.1 Emergency Procedures	• Explain the process for an evacuation drill • Explain the process for a lockdown drill • Locate Emergency shut-offs in shop • 100% on written safety test
9.1.2 Ergonomics	• Identify ergonomic risk factors in the workplace • Explain how ergonomic workplaces improve productivity • Identify some ergonomic techniques • 100% on written safety test
9.1.3 Safety Procedures	• Describe school-wide safety procedures • Follow shop safety rules • Maintain a clean work area/shop • 100% on written safety test

Technical Vocabulary:

Evacuation Drill, Lockdown Drill, Dress Code, Fire Extinguisher, Safety Rules, Eye Wash Station, Emergency Shut-off, Ergonomics.

Resources:

- **School Handbook**
- **Shop Safety Rules**
- **Internet**

Common Formative Assessment:

Safety Test

Priority Standard 9.2 - Career Opportunities

Big Idea(s):

- A solid background in mechanical design is a stepping stone to an engineering career
- Every design starts with an idea or a sketch
- It would be difficult to name an industry that does not use drawings

Essential Question(s):

- What are the essential personal and professional skills needed to be successful within this field?
- Why is visualization an important skill?
- How do you gain leadership experience and what soft skills help to increase the likelihood of your success?

Learning Outcomes

Students will know:	**Evidenced by: (oral, written, or performance)**
9.2.1 Career Opportunities	• List at least 4 career opportunities within the field of MDET • Cite skills needed to prepare for the various fields that use drafting
9.2.2 Basic Drafting Skills	• Explain why Drafting is called “Universal Language” • Describe why drawings are often the best way to describe or show ideas
9.2.3 Leadership Skills	• Identify some traits required to be a leader • Summarize the role of leadership in society and how it relates to MDET
9.2.4 Work Expectations	Describe what to expect when entering the world of work. *(Being Punctual, setting a good example, getting along with co-workers, getting involved in activities/projects, becoming part of a team.)*
9.2.5 Research Careers within the field	Name 5 occupations that require the ability to read and understand graphic language.

Technical Vocabulary:

Unit 1: Aerospace, Architectural, Computer graphics, Computer-aided Drafting and Design (CAD), Diagram, Drafting, Manually, Manufacture, Plotters, Printers, Symbols, Topographical.

Unit 2: Architects, Assistant drafter, CAD Drafter, CAD/CAM Specialist, Career information centers, Chief Communication, Computer graphics specialist, Computer graphics technician, Detail drafter, Detailer, Dictionary of Occupational Titles, Engineer, Industrial designer, Junior drafter, Lead Drafter, Leader, Leadership, Modelmakers, Occupational Outlook Handbook, Organizational qualities, Persistence, Responsibility, Senior Drafter, Skills USA, Teaching, Technical illustrator, Technology Student Association, Tool Designer, Trainee drafter, Vision.

Resources:

- Exploring Drafting by Walker and Mathis
  - Unit 1- Why study drafting
  - Unit 2- Careers in drafting and design
- Internet

Common Formative Assessment:

Goal 9.2 (Careers) Assessment

Priority Standard 9.3 - Basic drafting equipment

Big Idea(s):

- The ability to properly identify and select a tool is an essential skill for any tradesperson
- Principles of drafting are common to both traditional drafting and CAD

Essential Question(s):

- Why is it important to know what a tool is and its proper use?
- Why are scales important to drafters?

Learning Outcomes

Students will know:	Evidenced by: (oral, written or performance)
9.3.1 Basic Drafting Equipment	Identify common drafting equipment.
9.3.2 Use of Drafting Equipment	• Demonstrate safe use of tools • List 3 tools in drafting and explain their uses
9.3.3 Ergonomics	• Explain the importance of ergonomics • Use proper ergonomics in a shop setting
9.3.4 CAD vs Manual Drafting	• Explain how CAD changed the Drafting field • List 2 pros for both CAD & manual drafting

Technical Vocabulary:

Unit 4: Architect's scale, Beam compass, Circular, Circumference, Compass, CRT (cathode ray tube), Disk drive, Dividers, Drafting machines, Drawing board, Dusting brush, Engineer's scale, Erasers, Erasing shield, Ergonomics, French curve, irregular curve, Keyboard, Mechanical drafter's scale, Metric scale, Pencil pointer, Processor, Protractor, Ratio, Reproduction, Scales, Semiautomatic, Semicircular, Software, Templates, Transparent, Triangles, T-square, Vinyl.

Unit 24: Abacus, Auxiliary date storage units, Central processing unit, Computer, Computer Aided Design (CAD), Computer-aided design (CAI), Computer-aided manufacturing (CAM), Coordinates, Cursor, Data, Database, Design data, Digitizing tablet, Drawing database, Grid, Hard copy, Input device, Keyboard, Light Pen, Mainframe computer, Menu, Microcomputer, Microprocessor, Minicomputer, Mirrored, Monitor, Networking, Output device, Personal Computer (PC), Pixels, Plotter, Preliminary design, Program, Raster,
Raster image, Scanner, Stand-alone, system, Vector, Vector image.

Resources:

- Exploring Drafting by Walker and Mathis
  - Unit 4: Drafting Equipment
  - Unit 24: Computer-Aided Drafting and Design

Common Formative Assessment:

Goal 9.3 (Basic Drafting Equipment) “Base Plate”

Priority Standard 9.4 - Freehand lettering and sketching techniques

Big Idea(s):

- Sketching is a universal language
- Clear communication of ideas is essential

Essential Question(s):

Why would a sketch be considered a universal language?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
9.4.1 Hand lettering	Demonstrate proper techniques in producing neat freehand lettering on a drawing/sketch.
9.4.2 Engineering Sketching	• Produce a clear, neat, and proportionate 2D and 3D freehand sketches of given objects • Describe the steps to sketch the following: o Sketching circles o Sketching angles
9.4.3 The “Alphabet of Lines”	• Apply the proper line types to a sketch or drawing • Explain why the alphabet of lines uses different thicknesses and various line types and its importance on a drawing
9.4.4 Enlargement/Reduction Graph Methods	Using the graph method, enlarge or reduce a drawing of an object.

Technical Vocabulary:

Unit 3: Accuracy, Alphabet of Lines, Arc, Axis, Border line, Centerline, Conical, Construction line, Coordinates, Cutting-plane line, Diagonal, Diameter, Dimension line, Dimensions, Ellipse, Extension line, Geometric, Guide line, Hexagon, Hidden line, Horizontal, Inclined, Intersection, Object line, Octagon, Parallel, Radius, Right angle, Section line, Sketching, Symmetrical, Tangent, Terminate, Vertical.

Unit 6: Arc, Axis, Bisect, Circle, Circumscribe, Concentric, Diagonal, Diameter, Ellipse, Equilateral triangle, Geometric, Hexagon, Intersect, Length, Major Axis, Minor Axis, Octagon, Parallel, Parallelogram, Pentagon, Quadrant, Radius, Rectangle, Square, Tangent, Triangle, Vertical.

Unit 7: Ames lettering guide, Braddock lettering guide, Burnisher, Device, Dry Transfer materials, Engraved, Gothic, Legible, Lettering, Matrix, Microfilm, Pressure-sensitive materials, Single-stroke gothic alphabet, Stencil, Stylus.

Resources:

- Exploring Drafting by Walker and Mathis
  - Unit 3: Sketching
  - Unit 6: Basic Geometric Construction
  - Unit 7: Lettering

Common Formative Assessment(s):

Goal 9.4 (Lettering & Sketching Techniques) Assessment Part 1 & 2

Priority Standard 9.5 - Geometric constructions

Big Idea(s):

- Every object is composed of one or more geometric shapes
- Geometric shapes are essential elements of technical drawing, as they help to create accurate and clear representations of objects, structures, and systems
- Understanding basic geometric constructions is crucial to solving 3D problems in descriptive geometry
- Geometric constructions also simplify complex objects and systems into basic components that can be analyzed and understood

Essential Question(s):

- Why is the ability to recognize and create geometric shapes fundamental to becoming a draftsperson?
- Why are geometric shapes beneficial to technical drawing?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
9.5.1 Geometric construction terms	• Identify and describe basic geometric terms related to geometric construction • Label the geometric shapes on an assessment drawing
9.5.2 Bisecting elements	• Demonstrate how to bisect a given line • Demonstrate how to bisect a given arc • Demonstrate how to bisect a given angle
9.5.3 Angles and construction methods	• Identify various types of triangles • Explain the process of transferring angles from a given angle
9.5.4 Line segmenting	Demonstrate how to divide a given line into equal segments.
9.5.5 Identify and Construct basic polygons	• List the steps to constructing an octagon using a square • Label polygons on an assessment
9.5.6 Arc Tangent Construction	• Demonstrate how to draw an arc tangent to 2 straight lines • Demonstrate how to draw an arc tangent with a straight line and a given arc

Students will know:	Evidenced by: (oral, written, or performance)
9.5.7 Construct an ellipse	• Demonstrate the steps to constructing an ellipse • Explain how to construct an ellipse using the parallelogram method
9.5.8 Identify methods of geometric construction using lines	• Divide a line into a given number of equal divisions. • Use a line to construct an equilateral triangle.
9.5.9 Identify methods of geometric construction using circle	• Inscribe a hexagon using a circle. • Draw an octagon using a given circle. • Draw an ellipse using two concentric circles.
9.5.10 Identify parts of a triangle	• Sketch and label the parts of a triangle • Construct a triangle given line lengths

Technical Vocabulary:

Unit 6: Arc, Axis, Bisect, Circle, Circumscribe, Concentric, Diagonal, Diameter, Ellipse, Equilateral triangle, Geometric, Hexagon, Intersect, Length, Major Axis, Minor Axis, Octagon, Parallel, Parallelogram, Pentagon, Quadrant, Radius, Rectangle, Square, Tangent, Triangle, Vertical.

Supplemental Vocabulary: Altitude, Base, Center, Chord, Circumference, Eccentric, Equilateral, Heptagon, Horizontal, Hypotenuse, Inscribe, Isosceles, Line segment, Midpoint, Oblique, Perimeter, Perpendicular, Polygon, Rhomboid, Right, Scalene, Segment, Semicircle, Side, Vertex, Trapezoid

Resources:

- Exploring Drafting by Walker and Mathis
  - Unit 6: Basic Geometric Construction
  - Internet

Common Formative Assessment(s):

Goal 9.5 (Basic Geometric Construction)- “Template”

Priority Standard 9.6 - Orthographic projection principles

Big Idea(s):

- Orthographic projection is a technique used to create multiview drawings
- An orthographic drawing is a 2D representation of a 3D object

Essential Question(s):

- How are views used to describe an object?
- What methods are used to transfer depth on an orthographic drawing?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
9.6.1 Six basic views: ➢ Front ➢ Top ➢ Right ➢ Left ➢ Back ➢ Bottom	• List the 6 basic views of an object • Explain what the "glass box" method means • Identify the 3 primary views
9.6.2 Principle Dimensions: ➢ Height ➢ Depth ➢ Width	• Identify the 3 principle dimensions associated with orthographic projection • Label the 2 dimensions given in each view
9.6.3 Construct multiview drawings using orthographic projection.	• Demonstrate how to project height, width, length in corresponding views • Explain how to choose which views to draw

Technical Vocabulary:

Unit 8: Computer-aided design/Computer-aided manufacturing (CAD/CAM), Direction of sight, First angle projection, International standards Organization (ISO), Mechanical drawing, Multiview drawing, Orthographic projection, third angle projection.

Supplemental Vocabulary: Front View, Top View, Right Side, Bottom, Left Side, Rear\Back, Engineering Working Drawing, Foreshortening, Frontal Plane, Height, Horizontal Plane, Object feature, Orthographic Projection, Primary Projection Plane, Primary View, Profile Plane, True face, Width, Visualization.

Resources:

- ➢ Exploring Drafting by Walker and Mathis
  - Unit 8 Multi-view Drawings

Common Formative Assessment(s):

Goal 9.6 (Multiview Drawing)- "Rod Support" & "Stop Block"

Priority Standard 9.7 - Pictorial drawings principles

Big Idea(s):

- A pictorial drawing of an object is easier to understand than an orthographic drawing
- Pictorial drawings are used for many applications
- A pictorial drawing is a 3D representation of an object

Essential Question(s):

Why is the construction of a pictorial drawing easier to comprehend?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
9.7.1 Isometric drawings	• Center an isometric drawing on a sheet • Describe how isometric circles are drawn • Demonstrate the proper technique for creating an isometric drawing • Explain the angle isometric drawings are drawn at
9.7.2 Oblique drawings: ➢ Cabinet ➢ Cavalier	• Explain the process of creating an oblique drawing • List the two types of obliques drawings • Explain the difference between a cabinet and cavalier drawing

Technical Vocabulary:

Unit 12: Angular perspective, Cabinet oblique, Cavalier oblique, Cut-away pictorial drawing, Depth axis, Exploded assembly drawing, General oblique, Isometric drawing, Nonisometric lines, Oblique drawing, One-pt. perspective, Parallel perspective, Perspective drawing, Pictorial drawing, Receding lines, Structural details, Template, Two-pt. perspective, Vanishing point, Wireframe.

Resources:

- ➢ Exploring Drafting by Walker and Mathis
  - Unit 8 Multi-view Drawings

Common Formative Assessment(s):

Goal 9.7 (Pictorial Drawing)- “B- Clamp”

10th Grade Curriculum

Priority Standard 10.1 - Workplace Safety

Big Idea(s):

- Safety needs to be a habit and a consideration throughout daily living as well as in the work environment
- Training and awareness can prevent injuries
- Each person is responsible for following safety procedures

Essential Question(s):

Explain the procedures for various emergency evacuation plans.

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
10.1.1 Emergency Procedures	• Explain the process for an evacuation drill • Explain the process for a lockdown drill • Locate Emergency shut-offs in shop • 100% on written safety test
10.1.2 Ergonomics	• Identify ergonomic risk factors in the workplace • Explain how ergonomic workplaces improve productivity • Identify some ergonomic techniques • 100% on written safety test
10.1.3 Safety Procedures	• Describe school-wide safety procedures • Follow shop safety rules • Maintain a clean work area/shop • 100% on written safety test

Technical Vocabulary:

Evacuation Drill, Lockdown Drill, Dress Code, Fire Extinguisher, Safety Rules, Eye Wash Station, Emergency Shut-off, Ergonomics.

Resources:

- ➢ School Handbook
- ➢ Shop Safety Rules
- ➢ Internet

Common Formative Assessment:

- ➢ Safety Test
- ➢ OSHA 10 Credential

Priority Standard 10.2 - Orthographic drawings

Big Idea(s):

- The views that make up multiview drawings are developed using principles of orthographic projection
- The number of views needed to describe an object completely depends on its shape and characteristics
- Orthographic projection using either a first angle projection or third angle projection method

Essential Question(s):

- Why is there a “standard” orthographic method?
- What is the difference between first and third angle projection?
- How do you locate views on a drawing using accepted principles of drafting?

Learning Outcomes

Students will know:	**Evidenced by: (oral, written, or performance)**
10.2.1 Multiview drawing	• Identify the three normal views • Explain why visualization is important • List the 6 views of an object • Describe the “proper view selection” for a given object
10.2.2 Angles of Projection	• Explain the difference between first angle and third angle projection • Sketch and label the symbol for first and third angle projection
10.2.3 Glass box	• Explain the theory of projecting all sides using the “glass box” method • List, sketch, and properly label the six views of an object
10.2.4 Drawing the views	• Determine the number of views for drawing sample parts ○ #6-52 thru #6-55 • Describe the proper placement of views • Layout views for assigned problems
10.2.5 CAD Methods	• Explain how to create views independently using CAD • Demonstrate creating a multiview drawing using 3D solid modeling • Outline how a 3D model can help create 2D views

Students will know:	Evidenced by: (oral, written, or performance)

10.2.6 Principle Dimensions	• Identify the 3 principle dimensions in multiview drawing:
	  ○ Height
	  ○ Width
	  ○ Depth
	• Label the three on a drawing assessment

10.2.7 Laying out views using CAD	• Demonstrate how to offset lines • Explain what a solid model is and its purpose • Illustrate how to create a wireframe model
10.2.8 Conventional representation of manufacturing features such as: ➢ Fillets/Rounds ➢ Slots ➢ Grooves/Necks ➢ Counterbore ➢ Countersink ➢ Spot face ➢ Blind/Through holes	• Identify the conventional representation of these features on a drawing • Label the symbols for the features on a drawing

Technical Vocabulary:

Unit 6: Distorted, first-angle projection, Implementation, Locate, Multiview drawing, Normal view, Offset, Orthographic projection, Solid Model, Technical, Third-angle projection, Visualization, Wireframe.

Supplemental Vocabulary: Blind Hole, Counterbore, Countersink, Fillets, Grooves, Necks, Rounds, Slots, Spot face, Through hole.

Resources:

- Mechanical Drawing- Glencoe (STEM)
  - Unit 6- Multiview Drawing
  - Internet

Common Formative Assessment(s):

Goal 10.2- (Multiview Drawing)- “Actuator Base”

Priority Standard 10.3 - Dimensioning working drawings

Big Idea(s):

- A complete engineering drawing contains all necessary dimensions to accurately describe the part and its features so that it can be manufactured
- Notes and symbols give information about the type of finish and materials needed to make an object
- Size dimensions define the size of each piece, location dimensions give the size of each piece as well as its position in relation to the other pieces
- Technical drawings include geometric dimensions and tolerancing to define allowable differences in parts to be manufactured

Essential Question(s):

- Why are drafting standards used in industry?
- Why is it necessary to have an understanding of manufacturing processes?
- Why is accuracy necessary for all dimensions?
- How do accuracy and precision affect the production process?
- What is the purpose of geometric tolerancing and dimensioning?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
10.3.1 Basic dimensioning practices	• Identify the lines and symbols used for dimensioning • List the two basic types of dimensions • Define the difference between aligned and unidirectional dimensioning • List the steps necessary to add dimensions, notes, and geometric tolerances to a technical drawing in CAD
10.3.2 Dimensioning in different types of drawings	• Define a Detail Drawing • Explain why the dimensions are added in the final step on a Detail Drawing • Define an Assembly Drawing • Describe how dimensioning differs on an assembly drawing
10.3.3 Line types and symbols	• Match the corresponding term to its feature for the following: *Extension, extension, center, chamfer, tapers, curves, leader, diameter, radius, counterbore, countersink, spot face, depth, degrees, bolt circle, finish mark, square, reference.*

Students will know:	Evidenced by: (oral, written, or performance)
10.3.4 Dimensioning Techniques	• Describe two ways CAD streamlines the dimensioning process • List the steps in creating a CAD drawing • Specify how to set the dimension style on a CAD drawing • Indicate how accuracy and precision affect the production process • Define Limit dimensions
10.3.5 Tolerance	• Name and explain the two tolerance systems. • Define the term “tolerance” • Explain the difference between unilateral and bilateral tolerance systems • Give an example of a limit system
10.3.6 Dimensioning for Fits	• Describe the basic shaft system • Explain how to determine the limits for fits • Identify a basic shaft method tolerance • Identify a basic hole system tolerance
10.3.7 Geometric Dimensioning and Tolerancing (GD&T)	• Cite the purpose of GD&T • Explain how datums are used • Label a chart of the (14) ASME standard geometric conditions • List the three tolerance zones • Differentiate between the following: ○ Flatness and Parallelism ○ Cylindricity and Total runout ○ Perpendicularity and Angularity
10.3.8 Standard dimensioning methods	• Identify the following terms: *Unilateral Dimensioning, Aligned Dimensioning, Baseline Dimensioning, Chain Dimensioning, Tabular Dimensioning, Coordinate Dimensioning, Dual Dimensioning*

Technical Vocabulary:

Unit 7: Accumulate, Actual size, Aligned system, Allowance, Basic shaft system, Basic hole system, Basic size, Bilateral, Clearance, Datums, Dimension line, Finish mark, Geometric dimensioning and tolerancing, Limits, Nominal Size, Processes, Symbols, Tolerance, Unidirectional system, Unilateral.

Resources:

- Mechanical Drawing (Glencoe) STEM
  - Unit 7- Dimensioning

Common Formative Assessment:

Goal 10.3 (Dimensioning) - “Switch Dog”

Priority Standard 10.4 - Product Data Management (PDM)

Big Idea(s):

- Management of computer files, (aka PDM), is essential to controlling and sharing engineering data
- Throughout the course of a project, the engineering design team produces a variety of documents
- Drawings and other documents must be carefully numbered, cataloged, and stored so that they are protected and can be retrieved when needed

Essential Question(s):

- Why kinds of reports and graphic communication are used to document a project?
- What can you do to ensure your CAD files are not lost or damaged?
- What are the main concerns regarding electronic documents?
- Why is PDM important?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
10.4.1 Product Data Management (PDM)	• Explain how drawing files and retrieval systems are used for both hard copy and electronic documents • Describe several ways a design team uses and manages graphic communication
10.4.2 Types of Documents	• Explain why the production schedule plays an important role in an organization's operation • List the differences between managing board drawings vs. electronic drawings • Identify 3 types of documents used for PDM
10.4.3 Data Storage and Retrieval	• Give an example of both a short term & long term storage method of electronic documents • Outline methods of reproducing board and CAD drawings

Technical Vocabulary:

Unit 21: Closed filing system, Complexity, Diazo, Electrostatic reproduction, Flash drive, Ganhtt chart, Hard copy, Intermediate, Internet storage, Media, Microfilm, Network, PERT chart, Photo drafting, Product data management, Open filing system, Output.

Resources:

- ➢ Mechanical Drawing (Glencoe) STEM
  - Unit 21- Media Management (PDM)

Common Formative Assessment:

Goal 10.4- (PDM) - “Pipe Support Revision”

Priority Standard 10.5 - Section views

Big Idea(s):

- Sectional views are used to clarify the complexity of objects when internal features result in too many hidden lines
- Each of the various types of sectional views has a specific purpose; these views should not be used interchangeably
- The cutting plane line determines the orientation of the view and where the objects that are imagined to be cut

Essential Question(s):

- When does a part drawing require a section view?
- What are the different types of section views and their applications?
- How are webs, ribs and spokes represented in a section view?
- How does a drafter know where to place the cutting plane line?

Learning Outcomes

Students will know:	Evidenced by: (oral, written or performance)
10.5.1 Types of Sectional Views: ➢ Full ➢ Half ➢ Revolved ➢ Removed ➢ Broken-out ➢ Offset ➢ Aligned	• Describe the purpose of a section view • Identify the different types of sectional views • List the 2 most common types of section views
10.5.2 Cutting plane lines (CPL)	• Sketch the two ASME forms of a cutting plane line • Identify the most commonly used CPL • Lists section views that do not utilize a CPL
10.5.3 Section Line / Cross hatching	• Sketch the section lines for general use • Identify what section lines are called in CAD • Identify symbols used in sectioning
10.5.4 How to construct sectional views	• Explain why planning is important when creating a sectional view • List the advantages CAD gives for creating sectional views • List the steps used to create a sectional view
10.5.5 Feature Construction: ➢ Ribs ➢ Webs ➢ Spokes ➢ Hidden lines	• Explain when shafts, bolts, screws, rivets, and similar parts are usually not sectioned • Identify features that are not sectioned • Describe when some features are rotated to show true shape

Technical Vocabulary:

Unit 8: Aligned Section, Associative hatching, Auxiliary Section, Broken-out Section, Conventional Break, Cross hatching, Cutting-plane line, Full Section, Half Section, Hidden line, Material specification, Offset Section, Outline sectioning, Phantom Section, Removed Section, Revolved Section, Rib, Section lining, Sectional View, Spoke, Symmetrical, Web

Resources:

- Mechanical Drawing (Glencoe) STEM
  - Unit 8- Sectional Views

Common Formative Assessment(s):

Goal 10.5 (Sectional Views) “Truck Wheel”

Priority Standard 10.6 - Auxiliary view drawings

Big Idea(s):

- Auxiliary views are used to show the true shape and size of an inclined or oblique surface
- A primary auxiliary view is the first auxiliary view that is obtained from two principal views of an object
- A secondary auxiliary view is generated from a primary auxiliary view and one principal view
- When some curves can be omitted but the object is still completely described, a partial auxiliary view is acceptable

Essential Question(s):

- Why would you need to create an auxiliary view>
- When would you use a primary auxiliary and a secondary auxiliary view?
- How do you determine if a full or partial auxiliary is required?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
10.6.1 Auxiliary view(s): ➢ Primary ➢ Secondary	• Demonstrate when an auxiliary view is required on a drawing • Identify when a secondary auxiliary view is needed
10.6.2 Auxiliary view projection	• Lists the steps to create an auxiliary view • Sketch an auxiliary view from an assigned problem • Explain how to draw curves on an auxiliary view • Identify the angle of an auxiliary view
10.6.3 Construct primary auxiliary views	• Explain how to draw a front auxiliary view of an asymmetrical object using a vertical reference plane • Describe the situations in which a partial auxiliary view can be drawn
10.6.4 Construct secondary auxiliary views	• Identify the purpose of a secondary auxiliary view • Explain why it is important to understand the development of a primary auxiliary view before you can draw a secondary one

Technical Vocabulary:

Unit 9: Auxiliary view, Auxiliary plane, Axis of rotation, Edge view, Front auxiliary view, Inclined surface, Oblique Plane, Oblique surface, Partial auxiliary, Primary auxiliary, Projected, Reference plane, Revolution, Right-side auxiliary view, Section auxiliary, Secondary Auxiliary, True length, Top Auxiliary view.

Resources:

- Mechanical Drawing (Glencoe) STEM
  - Unit 9- Auxiliary Views

Common Formative Assessment:

Goal 10.6 (Auxiliary Views) “Angle Guide”

Priority Standard 10.7 - Development drawings

Big Idea(s):

- Pattern development is used extensively in the packaging industry for many products
- The three types of pattern development are parallel-line, radial-line, and triangulation
- Patterns can be developed for intersections, or combined shapes, such as prisms and cylinders
- The type of development needed for an individual object depends on the object's shape
- There are many diverse materials used in pattern developments

Essential Question(s):

- How are patterns used in designing for industry?
- What processes are used to form metal objects made from patterns?
- What specific shapes can be formed using pattern development?
- Why does the intersection of two 3D objects require special attention?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
10.7.1 Pattern developments	• List uses for pattern development in the packaging industry • Describe the general principles of pattern development • Identify the three main types of pattern developments
10.7.2 Parallel line development	• List the shapes that would require the use of parallel-line development • Explain what the term stretch-out line means
10.7.3 Radial line development	• Explain when a radial line development would be needed • List the shapes that would require the use of radial line developments • Determine the true length of the lateral edges of an oblique prism. (assign)
10.7.4 Triangulation	• List another term for triangulation • Describe how triangulation pieces are usually developed • Identify when the triangulation method would be used

Students will know:	Evidenced by: (oral, written, or performance)
10.7.5 Intersections: ➢ Prisms ➢ Cylinders ➢ Pyramids ➢ Cones	• Identify the first step for developing a pattern for intersecting objects • List examples of intersecting objects • Explain how patterns are developed for intersectional prisms and cylinders

Technical Vocabulary:

Unit 14: Approximate, Circumference, Cones, Convenient, Cylinders, Development, Diverse, Edges, Elbow, Hems, Lofting, Measuring line, Pattern, Parallel-line development, Prisms, Pyramids, Radial-line development, Seams, Sheet metal drafting, Stretch-out line, Surface, Transition piece, Triangulation, True length of a line, Truncated pyramid, Transition Piece.

Resources:

- ➢ Mechanical Drawing (Glencoe) STEM
  - Unit 14- Pattern Developments

Common Formative Assessment:

Goal 10.7 (Developments) “Truncated Prism”

Priority Standard 10.8 - Threads and non/threaded fasteners

Big Idea(s):

- The screw thread is the most common of the many different kinds of fasteners
- There are a variety of thread forms, fasteners, and applications
- The understanding of thread terminology is necessary for properly notating drawings
- Screw threads are divided into classes of fit based on their tolerances and allowances

Essential Question(s):

- Why is thread specification important to drafters and manufacturers?
- What is meant by the classification of screw threads?
- What is the best way to represent fasteners in different CAD drawings?

Learning Outcomes

Students will know:		Evidenced by: (oral, written, or performance)
10.8.1	Identification of threads and fasteners	• Label different types of threads on a sketch • Define common screw thread terms • Identify non threaded fasteners
10.8.2	Thread terminology	• Identify the following on a drawing of a thread: *Crest, root, pitch, axis, major diameter, minor diameter, thread angle, and lead.* • Calculate pitch for given threads
10.8.3	Thread forms and applications	• Identify the following threads and sketch a sample of each: *Unified, ACME, Taped pipe, Metric, Buttress, Knuckle, Sharp V, American National, Whitworth, Square*
10.8.4	Thread Specifications	• Breakdown thread callouts on a drawing • Using tables and charts determine thread conventions from a thread note
10.8.5	Thread Representations	• Identify and sketch the three types of thread representations • Explain when each one is used
10.8.6	Commonly used *threaded* fasteners and their applications	Identify the following threaded fasteners: *Nuts, bolts, cap screws, machine screws, setscrews, studs, ANSI, Metric*

Students will know:		Evidenced by: (oral, written, or performance)
10.8.7	Commonly used *non-threaded* fasteners and their applications	● Identify and explain the application for the following non-threaded fasteners: Keys, rings, pins, washers ● Match keys to appropriate sketches ● Explain the difference between a keyseat and a keyway

Technical Vocabulary:

Unit 11: ACME thread, American national, Attribute, Bolts, Block, Buttress, Crest, Detailed thread representation, External, Helix, Internal, Keyseat, Keyway, Keys, Knuckle, Lead, Left-hand thread, Major diameter, Metric, Minor diameter, Nut, Pin, Pitch, Rivets, Right-hand thread, ring, Schematic thread representation, Screws, Setscrew, Sharp "V", Simplified thread representation, Square, Stud, Symbol library, Tapered, Threads per inch, Tolerance, Tolerance class, Unified, Unified national course, Unified national extra fine, Unified national fine, Washers, Whitworth, Wood screws.

Resources:

- Mechanical Drawing (Glencoe) STEM
  - Unit 11- Fasteners

Common Formative Assessment(s):

Goal 10.8 (Threads and Fasteners)- "Thread identification chart"

11th Grade Curriculum

Priority Standard 11.1 - Workplace Safety

Big Idea(s):

- Safety needs to be a habit and a consideration throughout daily living as well as in the work environment
- Training and awareness can prevent injuries
- Each person is responsible for following safety procedures

Essential Question:

Explain the procedures for various emergency evacuation plans.

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
11.1.1 Emergency Procedures	• Explain the process for an evacuation drill • Explain the process for a lockdown drill • Locate Emergency shut-offs in shop • 100% on written safety test
11.1.2 Ergonomics	• Identify ergonomic risk factors in the workplace • Explain how ergonomic workplaces improve productivity • Identify some ergonomic techniques • 100% on written safety test
11.1.3 Safety Procedures	• Describe school-wide safety procedures • Follow shop safety rules • Maintain a clean work area/shop • 100% on written safety test

Technical Vocabulary:

Evacuation Drill, Lockdown Drill, Dress Code, Fire Extinguisher, Safety Rules, Eye Wash Station, Emergency Shut-off, Ergonomics.

Resources:

- School Handbook
- Shop Safety Rules
- Internet

Common Formative Assessment:

Safety Test

Priority Standard 11.2 - Mechanical working drawings

Big Idea(s):

- Working drawings must provide a complete, accurate, and to scale graphic representation of the project design concept
- Working drawings provide a safeguard and minimize the risk of expensive miscommunications between you and your team
- The composition of mechanical working drawings must conform to industry standards

Essential Question(s):

- What drawings are included in a set of working drawings and what are their purpose?
- Why is it important to cross-reference information between drawings and drawing specifications?

Learning Outcomes

Students will know:		Evidenced by: (oral, written, or performance)
11.2.1	Constructing a set of working drawings	• Outline the purpose of working drawings • Explain the setup for working drawings: *Choosing views, scale, grouping and placing parts, adding title block, bill of materials, and notes*
11.2.2	Standard working drawing types: ➢ Detail Drawing ➢ Assembly Drawing ➢ Combination Drawing ➢ Assembly Drawing ➢ Assembly Working Drawings ➢ Bill of Materials	• Identify three types of working drawing and their purpose • Properly label a set of working drawings
11.2.3	Bill of Material (BOM) Components	• Identify the name used by ASME for BOM • Describe why it is important that part numbers be unique to each part • List the parts of a BOM
11.2.4	Assembly Drawing supplemental components	• List the components for an assembly drawing: *Parts list (BOM), assembly procedure, item balloons, dimensions, manufacturing notes*
11.2.5	Working drawing formatting	• Specify the importance of a title block • Demonstrate the setup for the following: ○ Single sheet grouping ○ Multiple sheet set

11.2.6 Engineering Drawing Revision	• Specify the importance of proper drawing revisions • Demonstrate recording a revision on a working drawing
11.2.7 TBD	• Explain the engineering change process.

Technical Vocabulary:

Unit 14: Architect's scale, Assembly, Assembly sections, Balloons, Bill of Materials, Blueprints, Border, Combination drawings, Construction drawing, Cover sheet, Design/layout assembly, Detail drawing, Detail sections, Engineer's scale, Engineering change number (EC), Engineering Change Order, Exploded assembly drawing, General assembly, Installation assembly, Item number, Landscape, Layout drawing, Main assembly, Metric scale, Outline assembly drawing, Part, Part name, Part number, Parts list, Portrait, Profile views, Reference Assembly drawing, Reference dimensions, Revision block, Sheet size, Specifications, Sub-assemblies, Tabulated Drawing, Title block, Working assembly, Working drawing.

Resources:

- Engineering Design (2nd Edition) Lieu & Sorby
  - Unit 14- Working Drawings.

Common Formative Assessment:

Goal 11.2 (Working Drawings) - “Caster”

Priority Standard 11.3 - 3D Solid Modeling working drawings

Big Idea(s):

- Solid models are used in a variety of applications throughout the design and manufacturing processes
- Solid models must be built with sound modeling practices if they are to be useful in downstream applications

Essential Question(s):

- How do solid models support the entire product life cycle?
- What are some uses of solid models?
- What are some examples of good modeling strategies?

Learning Outcomes

Students will know:	**Evidenced by: (oral, written, or performance)**
11.3.1 Software interface	• Explain the purpose of the following toolbars: *Menu bar, Command manger, Feature manager design tree, Configuration manager, Property manager, Graphics area* • Complete a tutorial on the user interface of the 3D software
11.3.2 2D CAD sketching	• Describe why you should constrain a 2D sketch • Identify a weakness to 2D CAD systems • Define common terms related to 2D sketching: *Constraints, Origins, Planes, Axis, Coordinate system*
11.3.3 Constrained 3D solid modeling	Identify and explain common terms related to 3D modeling: *Sketch, Material, Extrude, Extrude cut, revolve, Revolve cut, Loft, Ribs, Swept, Surfacing, Threads, Fillets, Chamfers, Shell, Holes, Patterning, Mirroring, Draft, Configurations, Sheet metal, Weldments, Assemblies*
11.3.4 Detail and assembly drawings	• Name and describe three types of assembly constraints • Complete a tutorial on assemblies • Create a detail and assembly drawing • Identify relationships that are made when an assembly model is established

Students will know:	Evidenced by: (oral, written, or performance)
11.3.5 Assembly strategies and terminology	• List the primary difference between top down design and bottom up design • Define common terms associated with assembly drawings
11.3.6 Assembly animation	• Demonstrate how to animate assembly components using proper constraint methods • List two benefits of animating an assembly
11.3.7 Parametric design	• Create a parametric design and modify using a spreadsheet

Technical Vocabulary:

Unit 5: Associative constraints, Base feature, Blend, Blind extrusion, Chamfers, Constraints, Constructive solid geometry, Cut, Database, Datum geometries, Datum planes, Design table, Design tree, Dimensional constraints, Driven dimension, Extrusion, Features, Fillets, Geometric constraints, History tree, Holes, Mirrored feature, Model tree, Parameters, Parametric solid modeling, Path, Primitives, Profile, Revolved section, Ribs, Rounds, Shelling, Sketches, Sketching plane, Solid model, Splines, suppressed, Surface model, Swept feature, Trajectory, Unsuppressed, Vertex, Webs, Wireframe.

Unit 6: Assembly constraints, Associativity, Base instance, Bill of materials, Bottom up modeling, Clearances, Components, Exploded configuration, Hierarchy, Instances, Interference, Subassembly, Top down modeling.

Resources:

- Engineering Design (2nd Edition) Lieu & Sorby
  - Unit 5- Solid Modeling
  - Unit 6- Assembly Modeling

Common Formative Assessment(s):

Goal 11.3 (3D Solid Modeling)- “Fig. 13.54”

Priority Standard 11.4 - Tolerances

Big Idea(s):

- In engineering it is necessary to specify the intended fit between parts
- By utilizing standard practices for tolerance dimensioning, manufacturers can be confident that parts will fit together as intended
- In order for parts to fit together there is a need for varying degrees of accuracy (tolerances) depending on a parts functionality

Essential Question(s):

- What determines the tolerance method used?
- What are the advantages of using geometric dimensioning and tolerancing (GD&T) over conventional tolerancing?

Learning Outcomes

Students will know:		Evidenced by: (oral, written, or performance)
11.4.1	Tolerancing and machined surfaces	• Define the following terms: *ANSI Y14.5, Unilateral, Bilateral, Limits, Deviation, Clearance, Allowance, Nominal, Basic size, Fits, RC, LC, LN, LT, FN, General tolerances* • Identify functional features of a machined part that require specific tolerances
11.4.2	Standard Tolerances and Fits	• List the three types of fit • Calculate tolerances for given problems • Explain why tolerances and fits are important
11.4.3	Statistical Process Control	• List a con to statistical tolerancing • Select, calculate, and apply the appropriate shaft/hole fit tolerances on an assessment

Technical Vocabulary:

Unit 13: Allowance, ASME-ANSI Y14.5, Baseline dimensioning, Basic size, Bilateral, Chain dimensioning, Clearance, Limits, Datum, Datum reference frame, Deviation, Feature control frame, Fits, Forced Fits, General Tolerance, Interchangeable manufacturing, Interference, Locational Clearance, Locational Interference, Locational Transition, Maximum material condition, Unilateral, Running Clearance, Statistical Process Control (SPC), Statistical tolerancing.

Resources:

- Engineering Design (2nd Edition) Lieu & Sorby
  - Unit 13 - Tolerancing

Common Formative Assessment:

Goal 11.4 (Tolerancing) - “Caster”

Priority Standard 11.5 - Manufacturing processes and materials

Big Idea(s):

- Many factors influence product manufacturing beginning with research & development
- It is important to know how machining processes operate so that drawing specifications do not call out something that is not feasible to manufacture
- There is a variety of manufacturing materials and methods used to produce a design

Essential Question(s):

- How should a design change in order to match the fabrication method most suitable for its production volume?
- Why is it important to know several different fabrication processes in manufacturing?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
11.5.1 Manufacturing materials	• List two types of ferrous material • Identify a nonferrous material • List common parts made from alloys • Explain the difference between thermoplastics and thermosets
11.5.2 Heat treating process	Define the following terms: *Heat treating, Annealing, Tempering, Normaling, Quenched*
11.5.3 Common manufacturing methods	• List four machining methods • Describe the use of castings • Identify a method for both low volume production and high-volume production
11.5.4 Common measuring instruments	• Identify the common measuring instruments used in engineering and manufacturing: *Machinist's scale, inside and outside caliper, vernier calipers, micrometer, surface gauge.*
11.5.5 Welding methods and symbols	• List and describe four different types of welds • Define the following: *Fillet weld, Groove weld, Back weld, Spot weld, Seam weld, Projection weld, Flash weld.*

Technical Vocabulary:

Unit 16 (Engineering Design): 3-D printing, Blind hole, Boring, Brazing, Broach, Broaching, Casting, Deep drawing, Die, Die casting, Draft, Drill bit, Drilling, Drill press, Electric discharge machining (EDM), End mill, Extrusion, Fixture, Flash, Forging, Fused deposition, Grinding, Injection molding, Investment casting, Lathe, Milling, Milling machine, Mold, Pattern, Rapid prototyping, Reaming, Rolling, Sand casting, Sawing, Selective laser sintering (SLS), Sintering, Spindle, Split line, Sprue, Stage, Stamping, Standard commercial shape, Stereolithography (SLA), Tap, Tapped hole, Three-axis mill, Through hole, Tool bit, Tooling, Tumbling, Turning, Undercut feature, Welding, Wire drawing, Workpiece.

Unit 15 (Mechanical Design- Glencoe): Arc welding, Fillet weld, Gas welding, Gas & shielded arc welding, Groove weld, Fusion weld, Intermittent weld, Plug weld, Slot weld, Welding, Weldment.

Resources:

- Engineering Design (2nd Edition) Lieu & Sorby
  - Unit 16- Fabrication Processes
- Mechanical Drawing (Glencoe)
  - Unit 15- Welding Drafting

Common Formative Assessment:

TBD

Priority Standard 11.6 - Product Data Management (PDM)/revision control

Big Idea(s):

- Design revision is an integral element of the design process
- There are standardized procedures to efficiently control engineering documents to eliminate waste, reduce errors and assure quality control

Essential Question(s):

- What is the purpose of an Engineering Change Order?
- How does a PDM facilitate document control?

Learning Outcomes

Students will know:		Evidenced by: (oral, written, or performance)
11.6.1	Engineering change notice	• Explain the process and purpose of an engineering change order • Define the difference between ECO and ECN • Apply an ECO to an engineering working document • Create an ECO documenting changes to an engineering working drawing

Technical Vocabulary:

Engineering change order, Record of revision, Working drawing.

Resources:

- ANSI and ASME Standards
- Technical Drawing (Prentice Hall)
  - Unit 15- Drawing Reproduction/Control
  - ANSI and ASME Standards
- Internet

Common Formative Assessment(s):

TBD

Priority Standard 11.7 - Design practices and principles

Big Idea(s):

- Although the type of device or system you develop as an engineer may vary, the design process you employ will be the same regardless of the industry in which you work
- The design process is iterative, we repeat the processes as often as necessary to reach excellent solutions, improving as we go along by discovering new design possibilities and learning from our mistakes

Essential Question:

What is meant by concurrent engineering?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
11.7.1 Stages of design	• List in sequential order the 7 stages of the design process • Test and evaluate a given prototype
11.7.2 Design process	• Identify routine and non-routine problems that may occur during the design process • Identify which stage you would share your final design with others • Determine which stage you would learn from your mistakes and make your design better
11.7.3 Utilize the steps of the design process to solve a real-world design issues	• Research a design problem to create a solution for • Apply stages of design to a performance assessment

Technical Vocabulary:

Unit 4: Brainstorming, Concept mapping, Conceptual design, Design analysts, Design documentation, Design Process, Engineering design, Finite element analysis, Green engineering, Life cycle, Mass properties analysis, Model builders, Morphological chart, Problem identification, Prototype, Sustainable design, Visual thinking, Weighted decision table.

Resources:

- Engineering Design
  - Unit 4- Creativity and the Design Process
- Internet

Priority Standard 11.8 - Lean manufacturing principles

Big Idea(s):

- Lean manufacturing is a process that focuses on reducing waste to improve production and improve products
- Lean manufacturing is producing only the amount needed with minimal materials, equipment, labor, and space
- Lean manufacturing is developing business processes that achieve more output with the same resources

Essential Question(s):

- What are the manufacturing processes developed by lean manufacturing?
- What impact has lean principles had on the history of manufacturing?

Learning Outcomes

Students will know:		Evidenced by: (oral, written, or performance)
11.8.1	Lean manufacturing	• Define the concept for Lean • Outline the benefits of going Lean • Explain the following terms used in Lean: *Just in time manufacturing JIT, Total quality management TQM, 5S philosophy, Sort, Set in order, Shine, Standardize, Sustain Kaizen*
11.8.2	Lean manufacturing principles	• List and Identify the meaning of DMAIC • Explain the Lean journey • Describe how to apply Lean principles in your shop
11.8.3	Wastes associated with manufacturing and design	• List and define the 8 wastes associated with manufacturing and design: *Defects, Overproduction, Waiting, Not utilizing employees (knowledge, skills, ability), movement, Transportation, Motion, Excess processing* • Define and understand the difference between "Value Add" and "Non-Value Add"
11.8.4	Value stream mapping	• Demonstrate the process mapping for the following tasks: ➔ *Getting reading for school* ➔ *Making a sandwich* ➔ *Changing a tire* ➔ *Creating a Engineering Working drawing package* ➔ *Preparing for an oral presentation*

Technical Vocabulary:

Andon, FIFO (First In, First Out), Fluctuation Stock, Heijunka, Jidoka, Just-in-time Manufacturing (JIT), Kanban, Kaizen, Non-Value-Added, Poka Yoke, Pull System,
Standard-in-process stock, Standardized Work, Stop-Call-Wait, Total Quality Management (TQM), Toyota Production System (TPS), Value-Added, Value stream mapping, Visual Control, 5S Philosophy

Resources:

- Supplemental Lean Manufacturing Curriculum
- Internet

Common Formative Assessment(s):

TBD

12th Grade Curriculum

Priority Standard 12.1 - Workplace Safety

Big Idea(s):

- Safety needs to be a habit and a consideration throughout daily living as well as in the work environment
- Training and awareness can prevent injuries
- Each person is responsible for following safety procedures

Essential Question:

Explain the procedures for various emergency evacuation plans.

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
12.1.1 Emergency Procedures	• Explain the process for an evacuation drill • Explain the process for a lockdown drill • Locate Emergency shut-offs in shop • 100% on written safety test
12.1.2 Ergonomics	• Identify ergonomic risk factors in the workplace • Explain how ergonomic workplaces improve productivity • Identify some ergonomic techniques • 100% on written safety test
12.1.3 Safety Procedures	• Describe school-wide safety procedures • Follow shop safety rules • Maintain a clean work area/shop • 100% on written safety test

Technical Vocabulary:

Evacuation Drill, Lockdown Drill, Dress Code, Fire Extinguisher, Safety Rules, Eye Wash Station, Emergency Shut-off, Ergonomics.

Resources:

- ➢ School Handbook
- ➢ Shop Safety Rules
- ➢ Internet

Common Formative Assessment:

Safety Test

Priority Standard 12.2 - Geometric Dimensioning and Tolerancing

Big Idea(s):

- A thorough knowledge of dimensioning and tolerancing methods helps to ensure clear application of part requirements
- Geometric Dimensioning and Tolerancing is the use of symbols to express dimensioning and tolerancing requirements

Essential Question(s):

- What is the purpose of Geometric Dimensioning and Tolerancing?
- What is the purpose of a datum in relation to the Feature Control Frame?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
12.2.1 Geometric dimensioning & tolerancing GD&T	• Define GDT • Explain ASME-ANSI Y14.5 and its relation to geometric tolerances
12.2.2 GDT Datums	Identify the following GDT terms: *Datum, Point, Line, Axis, Area/Surface, Feature symbol, Feature surface, Feature control frame, Reference frame, Target symbol, Target area, Center plane.*
12.2.3 Form tolerances	• Identify form tolerance symbols • Explain the purpose of these symbols • List the types of form tolerances: *Flatness, Straightness, Cylindricity, Circularity.*
12.2.4 Profile tolerances	• List the types of profile tolerances: *Profile of a line, Profile of a surface.* • Identify when "profile tolerance" might be used
12.2.5 Orientation tolerances	• Identify orientation tolerance symbols • List the types of orientation tolerances: *Angularity, Perpendicularity, Parallelism*
12.2.6 Location tolerances	• Identify location tolerance symbols • List the types of location tolerances: *Position, Concentricity, Symmetry*

Students will know:	Evidenced by: (oral, written, or performance)
12.2.7 Runout tolerances	• Identify runout tolerance symbols • Explain the purpose of these symbols • List the types of runout tolerances: *Circular and Total*
12.2.8 Material modifier	• Identify and explain applying modifying symbols • Define the following: *Maximum material condition (MMC), Least material condition (LMC), Regardless of feature size, Perfect form @ MMC*
12.2.9 Feature control frames	• Identify a feature control frame and its purpose Define the following terms: *Geometric symbol, Tolerance information, Diameter symbol, Tolerance, Material modifier, Tolerance zone modifier, Datum Reference, Datum Precedence, Datum material modifier*
12.2.10 How to calculate tolerances	Calculate geometric tolerances for given produced sizes.

Technical Vocabulary:

Area/Surface, Axis, Center plane, Circularity, Cylindricity, Datum, Datum Material Modifier, Datum Precedence, Datum Reference(s), Feature Control Frame, Feature surface, Feature symbol, Flatness, Geometric Dimensioning and Tolerances (GDT), Geometric Symbols, Least Material Condition(LMC), Line, Maximum Material Condition(MMC), Perfect form @ LMC, Point, Reference frame, Regardless of Feature Size, Straightness, Target area, Target Symbol, Tolerance Zone Modifier.

Resources:

- Geometric Dimensioning and Tolerancing (Madsen)
- Internet

Common Formative Assessment:

Goal 12.2 (GD&T)- “Pin & Ring Geometric Assessment”

Priority Standard 12.3 - Project-based engineering design project

Big Idea(s):

- Design: An interactive or repeating decision-making process that results in a plan to produce a new product
- Technology brings both benefits and burdens
- Present day science and technology are tightly coupled
- Technology asks the question how? And Science asks the question Why?

Essential Question(s):

- What are some burdens that resulted from innovative designs?
- What is the role of ethics in design?
- What are the attributes of a successful engineering design team?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
12.3.1 How to evaluate form, fit and function of a design problem.	• Define the following: *Form, Fit, Function* • Explain the importance of form, fit and function as it relates to design
12.3.2 Compare and contrast causes of design failures.	• Research an example of a design failure • Explain the importance of comparing the causes of engineering failures
12.3.3 The role of ethics and safety in design	• Demonstrate the importance of comparing the influence of ethics, safety, and risks of a design problem • Explain how a design can reduce injuries, increase productivity, and make knowledge more accessible
12.3.4 Design for assembly	• Define what is meant by Design for assembly. (DFA) • List the three questions the Design for Assembly process involves • List some of the main principles of DFA
12.3.5 Engineering teams	• Outline who would make up an engineering team • List some important factors to consider when developing an engineering team

Students will know:	Evidenced by: (oral, written, or performance)
12.3.6 Assembly configurations	• Analyze assembly configurations and their use in design and manufacturing • Produce design configurations using 3D solid modeling software
12.3.7 Reverse engineering	• Define the meaning of "reverse engineering" • Explain the purpose of reverse engineering • Discuss an object you would be interested in reverse engineering
12.3.8 Evaluating a design	• Explain the impacts of testing a design • Discuss how a customer will evaluate a design in regards to the following: *Customer expectations, Life cycle, Safety, Costs, Environmental, Personal, Social, and Legal*
12.3.9 Working knowledge of emerging technologies	Explain the impacts of testing a design in regards to the following: *Green, Ergonomics, Lean*

Technical Vocabulary:

Configurations, Design for Assembly, Ethics, Green, Patents, Reverse Engineering

Resources:

- Engineering Design by: Karsnitz, O'Brien and Hutchison (Delmar publications)
- Engineering and Technology by: Hacker, Burghardt, Fletcher, Gordon, Peruzzi, Prestopnik
- Qaissaunee (Delmar publications)
- Internet

Common Formative Assessment:

Goal 12.3 (Design Project)- "Design Project Deliverables"

Priority Standard 12.4 - Gear and cam mechanism drawings

Big Idea(s):

- Various devices are used to transmit power and motion
- Gears can change rotation direction, rotation speed, and axis orientation
- Cams change rotational motion into reciprocating motion

Essential Question(s):

- What aspects of creating teeth for a gear are most likely to be of particular importance to drafters?
- What are the purpose and applications of gears and cams?
- What are the features of a typical gear drawing?

Learning Outcomes

Students will know:	Evidenced by: (oral, written, or performance)
12.4.1 Purpose and applications of gears and cams.	• Explain the purpose of gears and cams • Describe the three main types of cam motion • Determine the relationship between cam profile and a displacement diagram
12.4.2 Gear and cam terminology	Define the following terms: *Addendum, Base circle, Chordal addendum, Chordal thickness, Circular pitch, Circular thickness, Clearance, dedendum, Diametral pitch, Number of teeth, Outside diameter, Pitch circle, Pitch diameter, Pressure angle, Root diameter, Whole depth, Working depth, Involute Profile*
12.4.3 Common gears and applications	• List three types of common gears • Illustrate an example of a bevel gear, worm gear and spur gear • Explain how these gears are used
12.4.4 Create a set of working drawings with gears and cams	• Identify the following: *Spur gears, Work gears, Bevel gears, cams, mechanisms* • Produce a set of mechanical drawings that includes gears, cams, and mechanisms

Technical Vocabulary:

Unit 17: Addendum, Base circle, Bevel Gear, Cam, Chordal addendum, Chordal thickness, Circular pitch, Circular thickness, Clearance, Dedendum, Diametral pitch, Displacement diagram, Follower, Harmonic motion, Involute curve, Mechanism, Number of teeth, Outside diameter, Pinion, Pitch circle, Pitch diameter, Polar array, Pressure angle, Rectangular array, Root diameter, Spur Gear, Uniform motion, Uniformly accelerated and decelerated motion, Whole depth, Working depth, Worm Gear.

Resources:

- Mechanical Drawing (Glencoe)
  - Unit 17- Cams and Gears

Common Formative Assessment:

TBD