

Course Title:	Content Area:	Grade Level:	Credit (if applicable)
CAD and Solid Modeling	CTE: Engineering and Technical Sciences	9-12	0.5

Course Description:

This advanced course will further advanced students skills and knowledge of computer aided design (CAD). Advanced tools and modeling concepts will be applied to create complex mechanical parts. Modeling techniques and methods will be explored to find the most efficient approach to designing and manufacturing a part(s). Students will apply a design process through a variety of “hands on” projects. Mechanical parts will be created both virtually in CAD and then physically utilizing several manufacturing processes (3D printing, Laser Cutting, and CNC milling).

Aligned Core Resources:

Connection to the *BPS Vision of the Graduate*

- CRITICAL THINKING AND PROBLEM SOLVING
- Collect, assess and analyze relevant information
 - Reason effectively. Use systems thinking
 - Make sound judgments and decisions. Identify, define and solve authentic problems and essential questions.
 - Reflect critically on learning experience, processes and solutions
 - Transfer knowledge to other situations

**Additional Course Information:
Knowledge/Skill Dependent courses/prerequisites**

Link to *Completed Equity Audit*

Standard Matrix

Advance CTE Standard	Unit 1	Unit 2
ESS01.03: Demonstrate mathematics knowledge and skills required to pursue the full range of post-secondary education and career Opportunities. <ul style="list-style-type: none"> • Apply data and measurements to solve a problem. 	X	X
ESS02.01: Select and employ appropriate reading and communication Select and employ appropriate reading and communication strategies to learn and use technical concepts and vocabulary in practice. <ul style="list-style-type: none"> • Demonstrate use of content, technical concepts and vocabulary when analyzing information and following directions. • Interpret information, data, and observations to apply information learned from reading to actual practice. • Transcribe information, data, and observations to apply information learned from reading to actual practice. • Communicate information, data, and observations to apply information learned 	X	X

from reading to actual practice		
ESS02.02 Demonstrate use of the concepts, strategies, and systems for obtaining and conveying ideas and information to enhance communication in the workplace. <ul style="list-style-type: none"> Record information needed to present a report on a given topic or problem. 		X
ESS02.03 Locate, organize and reference written information from various sources to communicate with co-workers and clients/participants. <ul style="list-style-type: none"> Organize information to use in written and oral communications. 		X
ESS02.04 Evaluate and use information resources to accomplish specific occupational tasks. <ul style="list-style-type: none"> Use informational texts, Internet web sites, and/or technical materials to review and apply information sources for occupational tasks. 		X
ESS02.06 Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.		X
ESS02.09 Develop and interpret tables, charts, and figures to support written and oral communications. <ul style="list-style-type: none"> Interpret tables, charts, and figures used to support written and oral communication. 		X
ESS03.01 Employ critical thinking skills independently and in teams to solve problems and make decisions (e.g., analyze, synthesize and evaluate). <ul style="list-style-type: none"> Analyze elements of a problem to develop creative solutions. Use structured problem-solving methods when developing proposals and solutions. Critically analyze information to determine value to the problem-solving task. 	X	X
ESS03.04 Conduct technical research to gather information necessary for decision-making. <ul style="list-style-type: none"> Gather technical information and data using a variety of resources. 	X	X
ESS04.10 Employ computer operations applications to manage work tasks. <ul style="list-style-type: none"> Manage computer computer operations. Manage file storage. Compress or alter files. 	X	X
ESS04.11 Use computer-based equipment (containing embedded computers or processors) to control devices. <ul style="list-style-type: none"> Operate computer driven equipment and machines. Use installation and operation manuals Troubleshoot computer driven equipment and machines Access support as needed to maintain operation of computer driven equipment and machines 	X	X
Implement quality control systems and practices to ensure quality products and services. <ul style="list-style-type: none"> Describe quality control standards and practices common to the workplace. 		X
MNC10.01 Describe and employ technical skills and knowledge required for careers in manufacturing in order to perform basic workplace activities common to manufacturing activities common to manufacturing. <ul style="list-style-type: none"> Demonstrate the planning and layout processes (e.g., designing, print reading, measuring) used in manufacturing. 		X

<ul style="list-style-type: none"> Summarize how materials can be processed using tools and machines. Describe various types of assembling processes (e.g. mechanical fastening, mechanical force, joining, fusion bonding, adhesive bonding) used in manufacturing. Explain finishing processes (e.g., types of finishing materials, surface preparation, methods of application) used in manufacturing. Explain the processes of inspection and quality control used in manufacturing. 		
<p>MNPB04.01 Employ production process audits and inspections to maintain quality and encourage continuous improvement.</p> <ul style="list-style-type: none"> Check calibration of gauges and other data collection equipment. 		X
<p>MNPB05.01 Communicate with co-workers and/or external customers to ensure production meets business requirements.</p> <ul style="list-style-type: none"> Communicate material specifications and delivery schedules in a timely and accurate manner. 		X
<p>ACC01.01 Perform math operations such as estimating and distributing materials and supplies to complete jobsite/workplace tasks.</p> <ul style="list-style-type: none"> Use basic math functions to complete jobsite/workplace tasks. Use geometric formulas to determine areas and volumes of various structures. Use appropriate formulas to determine ratios, fractions, and proportion measures. Use appropriate formulas to determine measurements of dimensions, spaces and structures. Conceptualize a three-dimensional form from a two-dimensional drawing to visualize proposed work. 	X	X
<p>ACC03.02 Evaluate and adjust design and construction project plans and schedules to respond to unexpected events and conditions.</p> <ul style="list-style-type: none"> Identify and assess critical situations as they arise to resolve issues. 		X
<p>ACC10.01 Read, interpret, and use technical drawings, documents, and specifications to plan a project.</p> <ul style="list-style-type: none"> Interpret drawings used in project planning. Recognize how specifications and standards are arranged for proper access. Use the architect's plan, manufacturer's illustrations and other materials to communicate specific data and visualize proposed work. 	X	X
<p>ACPA06.02 Employ appropriate representational media to communicate concepts and design.</p> <ul style="list-style-type: none"> Convey graphic information using multi-dimensional drawings. Build models using referenced drawings and sketches. Utilize computer technology when communicating concepts and designs. 		X
<p>SCC06.01 Apply safety practices in the environment where science, technology, engineering, and/or mathematical principles are appropriate to ensure a safe workplace.</p> <ul style="list-style-type: none"> Apply appropriate safety and health practices when developing plans, projects, processes, or solving complex problems. Use appropriate safety techniques, equipment, and processes in planning and /or project applications. 		X

Unit Links

[Fusion 360 and MFG Overview](#)

[Manufacturing Strategies utilizing Fusion 360 applications](#)

Unit Title:

Fusion 360 and MFG Overview

Unit Summary and Relevant Standards: Bold indicates priority

In this unit, students will explore, learn, and utilize several design tools within Autodesk Fusion360 software to produce high-quality, complex, and precise part models. In addition, students will utilize the different design setups to virtually examine the manufacturing of their parts, to help make corrections and informed decisions on the manufacturing process being utilized.

Essential Question(s):

- What are the core differences between CAD and CAM, and how do they complement each other in the design and manufacturing process?
- How do you create and manipulate a design using Fusion360, from initial sketch to finalized part?
- What steps are involved in creating a manufacturing file using Fusion360, and how do you ensure the proper setup and settings for the chosen manufacturing process?

Enduring Understanding(s):**Understanding the Design-to-Manufacturing Process:**

- Students will understand the sequential process from conceptualizing a design to manufacturing a physical part, involving both CAD and CAM.
- They will comprehend how CAD is used for designing digital models, while CAM is utilized for generating instructions for manufacturing machines.
- Students will grasp the relationship between CAD and CAM, recognizing how they work together to streamline the production process.

Proficiency in Fusion360:

- Students will be proficient in using Fusion360 for both design and manufacturing purposes.
- They will understand how to initiate a design, select appropriate templates, and manipulate sketches to create 3D models.
- They will be able to use a variety of sketch and modeling tools within Fusion360 to add features and depth to their designs.

Applying Manufacturing Principles:

- Students will understand the principles behind manufacturing setups and processes.
- They will know how to create manufacturing setups in Fusion360 and select appropriate processes for a given part.
- They will be able to adjust manufacturing settings based on the chosen process to optimize production.

Integration of Design and Manufacturing:

- Students will understand the importance of integrating design and manufacturing considerations throughout the process.
- They will recognize how design decisions impact manufacturability and vice versa.
- They will be able to make informed design choices that take into account manufacturing constraints and requirements.

Problem-Solving and Adaptability:

- Students will develop problem-solving skills and

	<p>adaptability in using CAD/CAM software.</p> <ul style="list-style-type: none"> • They will be able to troubleshoot issues that arise during the design or manufacturing process. • They will understand the importance of flexibility in adjusting designs or manufacturing setups based on feedback or changing requirements.
Demonstration of Learning:	Pacing for Unit
Part and Process Setup within Fusion360	8 Weeks
Unit-specific Vocabulary:	Aligned Unit Materials, Resources, and Technology (beyond core resources):
2d Contour, 3d Modeling Tool, Adaptive Clearing, Axis, Baseline, Cad (Computer-Aided Design), Cam (Computer-Aided Manufacturing), Chamfer, Cutting, Design File, Clearance Height, Extrude, Feeds And Speeds, Fillet, Fusion360, Lead In/Out, Manufacturing File, Manufacturing Process, Manufacturing Setup, Navigation Bar, Orientation, Ramping, Rapid Movement Revolve, Shell, Sketch, Sketch Plane, Stock, Toolpath, View Cube, 3d Modeling.	Autodesk Fusion360
Differentiation through Universal Design for Learning	
UDL Indicator	Teacher Actions:
Expression and Communication: Use multiple tools for construction and composition; Build fluencies with graduated levels of support for practice and performance	<ul style="list-style-type: none"> • Provide appropriate Computer-Aided-Design (CAD) and Computer Aided Manufacturing (CAM) related scaffolding that can be gradually released with increasing independence and skills • Use web applications (e.g., wikis, animation, presentation) • Provide differentiated models to emulate (i.e. models that demonstrate the same outcomes but use differing approaches, strategies, skills, etc.) • Provide differentiated feedback (e.g., feedback that is accessible because it can be customized to individual learners) • Provide multiple examples of novel solutions to authentic problems
Supporting Multilingual/English Learners	
Related CELP standards:	Learning Targets:
<p>An EL can . . . participate in grade appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions.</p> <p>I can create a manufacturing file using Fusion360.</p> <p>Level 1: With prompting and support, use a very limited set of strategies to:</p> <ul style="list-style-type: none"> • Follow basic instructions to create a manufacturing file using Fusion360 • Use simple vocabulary to describe the steps involved in creating a manufacturing file • Respond to yes/no questions and some basic questions about creating a manufacturing file <p>Level 2: With prompting and support, use an emerging set of strategies to:</p>	

- Follow instructions to create a manufacturing file using Fusion360
 - Participate in short exchanges about creating manufacturing files using academic and domain-specific vocabulary
 - Respond to simple questions about the process of creating a manufacturing file
- Level 3: With guidance and support, use a developing set of strategies to:
- Discuss and ask questions about creating manufacturing files using Fusion360
 - Use academic and domain-specific vocabulary to describe the steps involved in creating a manufacturing file
 - Add relevant information and evidence to discussions about creating manufacturing files
 - Restate key ideas about creating manufacturing files expressed by others
- Level 4: Use an increasing range of strategies to:
- Engage in discussions and written exchanges about creating manufacturing files on various topics and issues using academic and domain-specific vocabulary
 - Build on the ideas of others regarding creating manufacturing files
 - Clearly express own ideas about creating manufacturing files with specific evidence
 - Ask and answer questions to clarify steps and concepts related to creating manufacturing files
 - Summarize key points discussed about creating manufacturing files
- Level 5: Use a wide range of strategies to:
- Participate in extended discussions and written exchanges about creating manufacturing files on substantive topics and issues using academic and domain-specific vocabulary
 - Build on the ideas of others to deepen discussions about creating manufacturing files
 - Clearly and persuasively express own ideas about creating manufacturing files with specific and relevant evidence
 - Refer to specific evidence from texts or research to support ideas about creating manufacturing files
 - Ask and answer questions that probe reasoning and claims related to creating manufacturing files
 - Summarize key points and evidence discussed about creating manufacturing files

Lesson Sequence	Learning Target	Success Criteria/Assessment/Resources
1 CAD vs CAM	I can explain the difference between Computer Aided Design (CAD) and Computer Manufacturing Design (CAM).	<ul style="list-style-type: none"> ● I can explain what CAD is and how it can be used. ● I can explain what CAM is and how it can be used. ● I can explain the difference between CAD and CAM
2 Fusion Design File	I can create a design file using Fusion360.	<ul style="list-style-type: none"> ● I can pick the appropriate template within Fusion360 to create a part. ● I can select the appropriate sketch plane (XY); (YZ); (XZ) to initiate part creation. ● I can utilize the view cube and navigation bar to adjust part orientation. ● I can utilize the appropriate sketch tools (i.e. line, rectangle, offset, trim, etc). ● I can finalize a sketch.
3 Depth to Drawings	I can use 3D modeling tools to create depth within a sketch	<ul style="list-style-type: none"> ● I can utilize the appropriate 3D modeling tools (i.e extrude, revolve, shell, fillet, chamfer etc) to add applicable features to the part.
4 Manufacturing File	I can create a manufacturing file using Fusion360	<ul style="list-style-type: none"> ● I can create a new manufacturing setup ● I can select the proper manufacturing process ● I can change and adjust manufacturing settings based on the chosen manufacturing process

Unit Title:

Manufacturing Strategies utilizing Fusion 360 applications

Unit Summary and Relevant Standards: Bold indicates priority

The second unit introduces students to the principles of part design utilizing Fusion 360 CAD software based on ideas, needs or design constraints. Students will learn how to implement the steps of the design process for transforming ideas into a production part. The creation of assemblies will be covered for design solutions which require the marriage of multiple parts. For existing parts which may need to be created or modified, the use of reverse engineering will give students the opportunity to recreate or improve on existing designs. Students will use additive or subtractive manufacturing processes to create a part or parts needed for an assembly.

Essential Question(s):

- How does the design process facilitate the transformation of an idea into a solution, and what are the key steps involved?
- What are the differences between additive and subtractive manufacturing, and how do they influence the design and production of parts?
- How can Fusion 360 be utilized to create files for different manufacturing processes, such as 3D printing, laser cutting, and CNC machining?

Enduring Understanding(s):**Design Process and Problem-Solving:**

- Students will understand the iterative nature of the design process, recognizing that it involves identifying problems, generating ideas, and refining solutions.
- They will comprehend the steps of the design process, including ideation, research, prototyping, and evaluation, and be able to apply each step to create effective design solutions.
- They will develop problem-solving skills by systematically applying the design process to address real-world challenges.
- **Manufacturing Methods and Their Implications:**
- Students will understand the differences between additive and subtractive manufacturing.
- They will recognize that additive manufacturing builds parts layer by layer, while subtractive manufacturing removes material from a solid block.
- They will be able to evaluate the benefits and drawbacks of each manufacturing method in terms of cost, speed, complexity, and material usage.

Application of CAD/CAM Tools:

- Students will understand how to use Fusion 360 to create files for different manufacturing processes.
- They will be able to create .stl files for 3D printing, PDF files for laser cutting, and G-code for CNC machining.
- They will recognize the importance of selecting the appropriate file format and settings based on the requirements of the manufacturing process.
- **Design Constraints and Evaluation:**
- Students will understand the importance of evaluating design solutions to ensure they meet design constraints.
- They will be able to identify and prioritize design

	<p>constraints such as size, material, functionality, and cost.</p> <ul style="list-style-type: none"> • They will develop the ability to critically evaluate design solutions and make revisions as needed to meet the desired criteria. <p>Interdisciplinary Skills and Collaboration:</p> <ul style="list-style-type: none"> • Students will recognize the interdisciplinary nature of the design and manufacturing process. • They will understand the importance of collaboration between designers, engineers, and manufacturers to develop and produce successful products. • They will develop communication skills necessary for effective collaboration and the ability to integrate feedback into the design process.
Demonstration of Learning:	Pacing for Unit
Variety of Projects	12 Weeks
Unit-specific Vocabulary:	Aligned Unit Materials, Resources, and Technology (beyond core resources):
Additive Manufacturing, Assembly, Cad (Computer-Aided Design), Cam (Computer-Aided Manufacturing), Constraints, Cnc Machining, Design Process, Evaluation, Collet, Caliper, Filament, Fusion 360, G-Code, Interdisciplinary, Iterative, Laser Cutting, Pdf (Portable Document Format), Prototyping, Stl File, Subtractive Manufacturing, Stock, Technical Drawing, 3d Printing, X Axis, Y Axis, Z Axis	Autodesk Fusion 3D printer(s) Laser printer(s) Machines - milling/ router/ lathe
Differentiation through Universal Design for Learning	
UDL Indicator	Teacher Actions:
Expression and Communication: Use multiple tools for construction and composition; Build fluencies with graduated levels of support for practice and performance	<ul style="list-style-type: none"> • Provide Computer-Aided-Design (CAD), music notation (writing) software, or mathematical notation software • Use web applications (e.g., wikis, animation, presentation) • Provide differentiated models to emulate (i.e. models that demonstrate the same outcomes but use differing approaches, strategies, skills, etc.) • Provide scaffolds that can be gradually released with increasing independence and skills (e.g., embedded into digital reading and writing software) • Provide differentiated feedback (e.g., feedback that is accessible because it can be customized to individual learners) • Provide multiple examples of novel solutions to authentic problems
Supporting Multilingual/English Learners	
Related CELP standards:	Learning Targets:

An EL can . . .participate in grade appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions.

I can demonstrate the use of Fusion 360 to create the necessary file(s) needed to export to a device to create a part.

Level 1: With prompting and support, use a very limited set of strategies to:

- Follow basic instructions to navigate Fusion 360.
- Use simple vocabulary to describe the basic functions of Fusion 360.
- Respond to yes/no questions and some basic questions about Fusion 360.

Level 2: With prompting and support, use an emerging set of strategies to:

- Navigate Fusion 360 with assistance to create simple files.
- Participate in short exchanges about using Fusion 360 with basic vocabulary.
- Respond to simple questions about the functions and features of Fusion 360.

Level 3: With guidance and support, use a developing set of strategies to:

- Demonstrate how to use Fusion 360 to create files for manufacturing with guidance.
- Engage in discussions about Fusion 360 using academic and domain-specific vocabulary.
- Add relevant information and evidence to discussions about using Fusion 360.
- Restate key ideas about using Fusion 360 expressed by others.

Level 4: Use an increasing range of strategies to:

- Independently demonstrate how to use Fusion 360 to create files for manufacturing.
- Engage in discussions and written exchanges about Fusion 360 on various topics and issues using academic and domain-specific vocabulary.
- Build on the ideas of others regarding using Fusion 360.
- Clearly express your own ideas about using Fusion 360 with specific evidence.
- Ask and answer questions to clarify steps and concepts related to using Fusion 360.
- Summarize key points discussed about using Fusion 360.

Level 5: Use a wide range of strategies to:

- Independently and proficiently demonstrate the use of Fusion 360 to create files for manufacturing on substantive topics and issues.
- Engage in extended discussions and written exchanges about Fusion 360 using academic and domain-specific vocabulary.
- Build on the ideas of others to deepen discussions about using Fusion 360.
- Clearly and persuasively express own ideas about using Fusion 360 with specific and relevant evidence.
- Refer to specific evidence from texts or research to support ideas about using Fusion 360.
- Ask and answer questions that probe reasoning and claims related to using Fusion 360.
- Summarize key points and evidence discussed about using Fusion 360.

Lesson Sequence	Learning Target	Success Criteria/Assessment/Resources
1	I can apply each of the steps of the design process to take an idea and turn it into a solution.	<ul style="list-style-type: none"> • I can explain what the design process is. • I can explain the steps of the design process • I can utilize each step of the design process to create a design solution • I can evaluate the design solution to insure it effectively meets design constraints
2	I can explain the difference between additive and subtractive manufacturing?	<ul style="list-style-type: none"> • I can name 3 additive manufacturing processes as well as the benefits and drawbacks of it • I can name 3 subtractive manufacturing processes as well as the benefits and drawbacks of it
3	I can demonstrate the use of Fusion 360 to create the necessary file(s) needed to export to a device to create a part.	<ul style="list-style-type: none"> • I can create a physical part utilizing Fusion 360 to create a .stl file and export it into MakerPrint for setup for a 3D printer. • I can create a physical part utilizing Fusion 360 for export as a pdf file into CorelDRAW for setup of a

		laser printer • I can create G-code utilizing Fusion 360 to export into a CNC machine for subtractive processing of a material
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