Computer Aided Design IV - Advanced Computer Aided Design for Architecture, Engineering, and 3D Animation

Course Information

Grade(s):	12
Discipline/Course:	TechnologyEducation
Course Title:	Computer Aided Design IV - Advanced Computer Aided Design for Architecture, Engineering, and 3D Animation
Prerequisite(s):	Computer Aided Design III: Intermediate CAD for 3D Animation, Architecture, and Engineering (Full Year) *or* Computer Aided Design III: Intermediate CAD for 3D Animation, Architecture, and Engineering (Semester) with teacher's permission.
Course Description: *Program of Studies*	Advanced design using various Computer Aided Design (CAD) programs specializing in the areas of: Architecture, Animation, and Engineering. Students will utilize CAD professional level software to construct 3D computer models of houses, simple parts and mechanisms, and textured 3D models which could be used as assets in games or animations. Activities will include: hand sketching, creating 3D computer models, rendering still images and video, using a 3D printer to create actual parts made of plastic, and creating a basic keyframe animation.
Course Essential Questions:	● How do people use drawings and computer software to design the objects around us? ● What tools are used to create designs, computer models, and physical prototypes? ● What is the design process used to go from concepts to finished products? ● How is important information communicated during the design process?
Course Enduring Understandings:	● 3D real world objects can be represented by 2D orthographic and perspective drawings. ● Real world products follow an organized design process to go from concept to completion.
Duration/Credit:	Full Year Course / 1 credit(s)
Course Materials/ Resources:	Drawing tools, computers, software, projector/screen, 3D printing technology, basic hand tools.

FPS Course Academic Expectation(s):	CI: Conveying Ideas, CC: Creating and Constructing, UCT: Using Communication Tools
Year at a Glance (Units):	**Unit 1** Unit 1.A.-Architecture - The architectural design process Unit 1.B.-Engineering - The engineering design process Unit 1.C.-Animation - Practicing Sketching and storyboarding **Unit 2** Unit 2.A.-Architecture - Advanced 3D modeling Unit 2.B.-Engineering - Advanced 3D modeling Unit 2.C.-Animation - Advanced 3D modeling **Unit 3** Unit 3.A.- Architecture - Advanced Working Drawings Unit 3.B.- Engineering - Advanced Working Drawings Unit 3.C. -Animation - Advanced Rendered Images and Video **Unit 4** - Capstone Project with Portfolio Completion (All)

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Architecture Unit 1

Unit Number and Title:	Unit 1.A.-Architecture - The Architectural Design Process
Duration:	6 weeks
Resource(s):	Computers, projector, consumables
Unit Overview:	In this unit students continue exploring how architects use customer input to design ideal livable spaces for them. We explore the relationship between spaces requested by the client to determine the optimal design and then create floor plans, elevations and any necessary drawings to give a better sense of the final structure.
Learning Goals	
Standard(s):	ARCH.02 Demonstrate an understanding of socio-cultural and environmental impacts on architectural design. ARCH.06 Develop technical drawings drafted by hand and computer aided drafting and design(CADD). ARCH.07 Employ appropriate media to communicate concepts and design.
Essential Question(s):	● What are common considerations which must be taken into account when designing architectural spaces? ● How can I communicate my design ideas clearly and efficiently? ● What conventions exist to ensure all architectural drawings are uniform?
Enduring Understanding(s):	● The main job of architectural design is to create spaces tailored to clients' needs ● There must be a balance between functionality and aesthetics.
Learning Goal(s): *Students will know and will be able to use their learning to:*	**Content:** (Students will know…) ● selection and use the appropriate pencil type for constructions and object lines. ● difference between sketching and CAD drawn floor plans.

(Content/ Skills)	**Skills:** (Students will be able to…)
	● create hand drawings of two dimensional primitives.
	● create simple orthographic drawings of 3 dimensional objects.
	● apply information in creative ways to satisfy client needs

Architecture Unit 2

Unit Number and Title:	Unit 2.A.-Architecture - Advanced 3D modeling
Duration:	12 weeks
Resource(s):	Computers, projector, paper, pencils, erasers
Unit Overview:	Using the drawings created in unit 1 students will begin creating a 3D computer model of their design. Students will learn the basic architectural CAD tools like placing walls, floors, doors, windows, roofs, terrain, plants, as well as adding appropriate textures on those surfaces to simulate actual building materials and landscape elements.
Learning Goals	
Standard(s):	ARCH.03.02 Evaluate a site that takes into consideration local, state and national restrictions, zoning and codes. ARCH.03.03 Differentiate between residential and commercial building codes/standards ARCH.04.04 Develop and communicate an assigned building design. ARCH.05.01 Apply prior knowledge to discuss daily needs and influences identified in their environment. ARCH.05.02 Produce preliminary designs, final sketches and presentation drawings.
Essential Question(s):	● How can 3D modeling be used to create more sustainable and efficient buildings? ● How can 3D modeling be used to explore new and innovative architectural forms? ● How can basic drafting tools for textures and material simulations be used to create more realistic and immersive architectural renderings? ● How can CAD and basic drafting tools for textures and material simulations be used to explore new and innovative architectural forms?
Enduring	● CAD is a powerful tool for designing, drafting, and rendering architectural drawings. It allows

Understanding(s):	architects to create precise and accurate drawings, experiment with different design ideas, and communicate their designs to others in an effective way. ● CAD and basic drafting tools for textures and material simulations can be used to explore new and innovative architectural forms. These tools allow architects to create digital prototypes of their designs and to test different design ideas in a virtual environment. ● CAD and basic drafting tools for textures and material simulations are essential tools for architects in the 21st century. These tools allow architects to create more sustainable, equitable, resilient, and innovative architecture.
Learning Goal(s): *Students will know and will be able to use their learning to:* (Content/ Skills)	**Content:** (Students will know…) ● workflow involved in going from 2D concept drawings to a finished 3D computer model of a basic residence **Skills:** (Students will be able to…) ● create terrain- to simulate an actual building site ● build CAD Models in 3D from 2D sketches ● add basic elements to a building model like doors and windows and change their types to match a desired aesthetic style ● insert and modify furniture and fixtures as component files. ● create site features like driveways and walkways ● add landscaping elements to create a more attractive site ● create new materials and apply them to surfaces to simulate actual building and site materials

Unit Number and Title:	Unit 3.A.- Architecture - Advanced Working Drawings
Duration:	6 weeks
Resource(s):	Computers, projector, paper, pencils, erasers
Unit Overview:	Following the 3D models students learn how to create dimensioned floor plans, elevation views, and realistic rendered images to communicate the final design to customers and construction managers.
Learning Goals	
Standard(s):	ARCH.06 Develop technical drawings drafted by hand and computer aided drafting and design(CADD). ARCH.05.02 Produce preliminary designs, final sketches and presentation drawings.
Essential Question(s):	● How can elevations and floor plans with dimensions be used to create accurate and realistic 3D CAD models of buildings? ● How can elevations and floor plans with dimensions be used to communicate design ideas to clients and stakeholders? ● How can elevations and floor plans with dimensions be used to generate building permits and other construction documentation?
Enduring Understanding(s):	● Elevations and floor plans with dimensions are essential tools for architects to create accurate and realistic 3D CAD models of buildings. ● Elevations and floor plans with dimensions can be used to communicate design ideas to clients and stakeholders. ● Elevations and floor plans with dimensions are essential components of building permits and other construction documentation.
Learning Goal(s): *Students will know and will*	**Content:** (Students will know…) ● how to produce preliminary designs, final sketches and presentation drawings by hand and

be able to use their learning to: (Content/ Skills)	computer aided drafting and design(CAD). **Skills:** (Students will be able to…) ● create dimensioned floor plan drawings ● create elevation drawings with appropriate labeling ● add camera views and adjust them for optimal viewing angles ● render realistic still images of their CAD model. ● set up sheet views with the proper scale for printing

Engineering Unit 1

Unit Number and Title:	Unit 1.B.-Engineering - The engineering design process
Duration:	6 weeks
Resource(s):	Computers, projector, consumables
Unit Overview:	In this unit students will discover that the Engineering Design Process (EDP) is a multistep, iterative process that involves careful and intentional planning steps in order to meet the needs of people. We will practice isometric and orthographic drawing techniques commonly used in the engineering and product development fields to quickly communicate design concepts.
Learning Goals	
Standard(s):	ENG.02.01 Identify the components of the design process: define the problem, brainstorm, research, develop solutions, prototype, test/evaluate, and communicate results. ENG.05.04 Actively contribute to a team project. ENG.05.05 Identify the following characteristics of an effective design team: team norms, leadership, responsibility, respect, rapport, and time management. ENG.07.04 Describe and demonstrate the process for using CAD in a design solution.
Essential Question(s):	● How can I communicate my design ideas clearly and efficiently? ● What conventions exist to ensure all mechanical drawings are uniform? ● How can the EDP help me with my Design planning and execution?
Enduring Understanding(s):	● The engineering design process (EDP) is a multi step iterative process that engineers use to solve problems and create new products, processes, and systems. ● The EDP It is a cyclical process that involves identifying the problem, brainstorming solutions, designing a solution, building a prototype, testing the prototype, and refining the design. ● The EDP is iterative because engineers often need to go back and forth between steps as they learn more about the problem and their solution.

Learning Goal(s):	Content: (Students will know…)
Students will know and will be able to use their learning to: (Content/ Skills)	● the EDP is a multi step iterative process used to solve problems and create new products, processes, and systems. ● the EDP is cyclical and involves: identifying the problem, brainstorming solutions, designing a solution, building a prototype, testing the prototype, and refining the design. ● the EDP is iterative because one goes back and forth between steps as they learn more about the problem in search of a solution. Skills: (Students will be able to…) ● create hand drawings from two dimensional primitives. ● list the common types of lines used in mechanical drawings. ● create simple orthographic and isometric drawings of 3 dimensional objects.

Engineering Unit 2

Unit Number and Title:	Unit 2.B.-Engineering - Advanced 3D modeling
Duration:	12 weeks
Resource(s):	Computers, projector, paper, pencils, erasers
Unit Overview:	Students will create 3D CAD models from 2D computer sketches which represent single parts. We will also learn how to make simple assemblies combining a few part files to simulate a basic machine. Practicing file management is key when using parametric modeling in order for assembly files to function. During this unit students will learn how to properly export files into the correct format for 3D printing actual parts.
Learning Goals
Standard(s):	ENG.05.05 Identify the following characteristics of an effective design team: team norms, leadership, responsibility, respect, rapport, and time management. ENG.07.04 Describe and demonstrate the process for using CAD in a design solution. ENG.09 Demonstrate the application of science and math principles to the fluids engineering process. ENG.11.01 Describe and apply the following mechanical systems principles: Law of Conservation of Energy, six simple machines, mechanical advantage, efficiency, work, rate, and friction/resistance.
Essential Question(s):	- How can parametric CAD software be used to create parts that are flexible, easy to assemble and adaptable to different designs? - How can parametric CAD software be used to create parts that are manufacturable? - How can parametric CAD software be used to improve the quality of products and reduce the time and cost of product development?
Enduring Understanding(s):	Parametric CAD files are a powerful tool for creating and assembling complex parts and assemblies.

	● Parametric CAD files can be used to create assemblies that are made up of many different parts. ● Parametric CAD files can be used to generate manufacturing drawings and other documentation.
Learning Goal(s): *Students will know and will be able to use their learning to:* (Content/ Skills)	**Content:** (Students will know…) ● simple assemblies simulating a basic machine can be made by combining a few part files. ● file management is key when using parametric modeling in order for assembly files to function. ● 3D printing of parts they design. **Skills:** (Students will be able to…) ● create fully constrained 2D CAD sketches. ● manipulate 2D sketches using editing tools and transforms. ● create 3D part models from 2D sketches. ● create fully constrained 3D part assemblies. ● test digital prototypes by applying basic physics simulations in CAD ● export CAD models for 3D printing

Engineering Unit 3

Unit Number and Title:	Unit 3.B.- Engineering - Advanced Working Drawings
Duration:	6 weeks
Resource(s):	Computers, projector, consumables
Unit Overview:	During this time students will learn the process for converting their 3D CAD models into dimensioned drawings needed by manufacturers in order to physically construct their designs in a factory or workshop. Basic ANSI dimensioning conventions will be applied. In addition to dimensioned drawings we will learn how to create realistic colored renderings of 3D still images and videos of physics simulations on their machines.
Learning Goals	
Standard(s):	ENG.02.01 Identify the components of the design process: define the problem, brainstorm, research, develop solutions, prototype, test/evaluate, and communicate results. ENG.05.04 Actively contribute to a team project. ENG.05.05 Identify the following characteristics of an effective design team: team norms, leadership, responsibility, respect, rapport, and time management. ENG.07.04 Describe and demonstrate the process for using CAD in a design solution. ENG.05.05 Identify the following characteristics of an effective design team: team norms, leadership, responsibility, respect, rapport, and time management. ENG.07.04 Describe and demonstrate the process for using CAD in a design solution.
Essential Question(s):	● How can dimensioned drawings be created that are accurate, complete, and easy to understand? ● How can dimensioned drawings and renderings be used together to improve the manufacturing process? ● How can dimensioned drawings and renderings be adapted to the needs of different manufacturing processes? ● How can renderings be used to communicate design ideas to manufacturers and to visualize the

	finished product?
Enduring Understanding(s):	• Dimensioned drawings are essential for the communication of design intent to manufacturers. • Renderings can be used to communicate the design intent to manufacturers more effectively than dimensioned drawings alone. • Manufacturers need different types of dimensioned drawings and renderings depending on the product or component being manufactured.
Learning Goal(s): *Students will know and will be able to use their learning to:* (Content/ Skills)	**Content:** (Students will know…) • process for converting their 3D CAD models into dimensioned drawings • basic ANSI dimensioning convention. • how to create realistic colored renderings of 3D still images and videos of physics simulations using CAD software. **Skills:** (Students will be able to…) • create dimensioned drawings from part files and assembly files. • correctly apply basic ANSI dimensioning standards • create video animations showing the functionality of assembly files and simulations.

Animation Unit 1

Unit Number and Title:	Unit 1.C.-Animation - Practicing Sketching and storyboarding
Duration:	4 weeks
Resource(s):	Computers, projector, paper, pencils, erasers
Unit Overview:	Students continue creating concept sketches and storyboards. Students advance to designing 3D models and animations used in many industries including video games, film, advertising, and cartoons. Students learn communication tools that are invaluable to teams for understanding a shared vision of a quality product.
Learning Goals	
Standard(s):	AVC.03.01 Select equipment required for specific types of audio productions. AVC.03.15 Identify types of software used in the development of media (IE: video files. game design files. and animations). AVC.03.16 Demonstrate how to use software for developing a message. AVC.04.03 Describe the significance of digital technology production, and the required equipment related to editing. DVP.03 Pre-Production: Describe the process used for concept development and storyboarding as part of the pre-production process while focusing on the importance of communication, deadlines, and legal considerations. DVP.06 Post-Production: Identify and describe the elements of post-production to effectively deliver a message. DVP.07 Media Components and Concepts: Identify and understand the technological literacy of video production.
Essential Question(s):	- How will I begin the Animation? What is my story idea, character design, or world setting? - How do I storyboard my idea as a visual representation of the story; to plan out the shots,

	scenes, and dialogue? ● How do I design and model the characters and other objects in my animation using traditional 2D animation techniques or 3D computer-generated imagery (CGI)? ● Now that I have created my characters and backgrounds how do I begin the animation process using a series of still images played back in sequence to create the illusion of movement?
Enduring Understanding(s):	● Animation is a complex process, but it can be summarized in three main steps: ● Pre-production: The concept, storyboard, and animatic are created. ● Production: The characters, backgrounds, and animation are created. ● Post-production: The different elements of the animation are combined, edited, and sound is added.
Learning Goal(s): *Students will know and will be able to use their learning to:* (Content/ Skills)	**Content:** (Students will know…) ● 3D model animations used in many industries including video games, film, advertising, and cartoons. ● communication tools for team understanding of a shared vision of a quality product. **Skills:** (Students will be able to…) ● use basic 2D primitives to draw character concept sketches ● create a basic storyboard to plan out a short animation ● communicate their ideas in a team environment. ● model an idea using 3D modeling software.

Animation Unit 2

Unit Number and Title:	Unit 2.C.-Animation - Advanced 3D modeling
Duration:	14 weeks
Resource(s):	Computers, projector, paper, pencils, erasers
Unit Overview:	Students will learn the basic modeling, texturing, and lighting tools needed to create 3D computer models used in industries ranging from video games, animations, architecture, and special effects. We will practice modeling with 3D primitives and simple editable polygon shapes. Students will learn how to use some of the common modifiers to manipulate those shapes or adjust textures to fit better. We will add lighting to the scene to control the look of textures and shadows. Basic keyframing techniques will be explored to make their models move on the screen.
Learning Goals	
Standard(s):	AVC.03.15 Identify types of software used in the development of media (IE: video files. game design files. and animations). AVC.03.16 Demonstrate how to use software for developing a message. AVC.04.03 Describe the significance of digital technology production, and the required equipment related to editing. DVP.03 Pre-Production: Describe the process used for concept development and storyboarding as part of the pre-production process while focusing on the importance of communication, deadlines, and legal considerations. DVP.06 Post-Production: Identify and describe the elements of post-production to effectively deliver a message.
Essential Question(s):	- How can we create realistic and believable lighting and shadows in 3D computer models? - How can we use lighting and shadows to create different moods and atmospheres in our 3D scenes?

	● How can we use lighting and shadows, along with other modifiers, to create a sense of depth and realism in our 3D scenes enhancing the overall aesthetic quality?
Enduring Understanding(s):	● When light interacts with an object, it casts a shadow. The size, shape, and intensity of the shadow depend on the position and brightness of the light source, as well as the properties of the object. ● There are many different types of light sources in 3D computer modeling. ● Some common types of light sources include directional lights, point lights, and spot lights. ● Different types of materials interact with light in different ways. For example, reflective materials reflect light, while diffuse materials scatter light. ● The way that a material interacts with light determines its appearance in the rendered scene. ● Lighting and shadows can be used to create a wide range of moods and atmospheres in 3D scenes.
Learning Goal(s): *Students will know and will be able to use their learning to:* (Content/ Skills)	**Content:** (Students will know…) ● modeling, texturing, and lighting tools needed to create 3D computer models used in animations and special effects. ● modeling with 3D primitives and simple editable polygon shapes. ● how to use some of the common modifiers to manipulate those shapes or adjust textures to fit better. ● lighting controls to establish a scene for the look of textures and shadows. ● basic keyframing techniques that make their models move on the screen. **Skills:** (Students will be able to…) ● create basic primitive shapes and prepare them for modeling. ● create an original low polygon character model. ● create a basic set for the character to exist within ● apply premade materials to 3D objects to give them color and shading properties. ● use the internet and computer software to create and apply their own custom PBR textures.

	● utilize keyframe animation techniques to produce a short animation. ● load in an HDRI to create lighting and shadows

Animation Unit 3

Unit Number and Title:	Unit 3.C. -Animation - Advanced Rendered Images and Video
Duration:	6 weeks
Resource(s):	Computers, projector, consumables
Unit Overview:	Once the modeling and animation is complete students learn how to control cameras and fine tune the render engine settings to get their finished still and video renders to look great while efficiently balancing system resources used to avoid excessive render times. Students will learn how to use professional video editing software to convert image sequences into fully rendered video.
Learning Goals	
Standard(s):	AVC.03.15 Identify types of software used in the development of media (IE: video files. game design files. and animations). AVC.03.16 Demonstrate how to use software for developing a message. AVC.04.03 Describe the significance of digital technology production, and the required equipment related to editing. DVP.03 Pre-Production: Describe the process used for concept development and storyboarding as part of the pre-production process while focusing on the importance of communication, deadlines, and legal considerations. DVP.06 Post-Production: Identify and describe the elements of post-production to effectively deliver a message.
Essential Question(s):	- What are the fundamental principles of rendering? - How can we use rendering to create realistic and believable images and videos? - How can we use rendering to create different moods and atmospheres in our images and videos? - How can we use rendering to tell stories and communicate ideas? - How can we use rendering to create new and innovative forms of art and entertainment?

Enduring Understanding(s):	- Rendering is the process of converting a 3D scene into a 2D image or video. - There are many different factors that affect the quality of a rendered image or video. - One can experiment with different lighting and material settings to see how they affect the appearance of a rendered image or video. - Students can learn about the different factors affecting rendered image quality, such as resolution and sampling. - Students can use their rendering skills to create a variety of different projects, such as video game assets, animated shorts, or product visualizations.
Learning Goal(s): *Students will know and will be able to use their learning to:* (Content/ Skills)	**Content:** (Students will know…) - camera controls to fine tune the render engine settings and get finished still and video renders to look great while efficiently balancing system resources. - balancing system resources to avoid excessive render times is important. - professional video editing software can convert image sequences into fully rendered video. **Skills:** (Students will be able to…) - create camera views. - adjust exposure values to balance lighting. - modify render engine settings to balance quality and efficient render times. - Create high quality rendered still images. - export image sequences. - combine image sequences into quality rendered video files.

Unit 4

Unit Number and Title:	Unit 4 - Capstone Project with Portfolio Completion
Duration:	16 weeks
Resource(s):	Computers, projector, paper, pencils, erasers
Unit Overview:	Students will use their knowledge of the design process to create hand sketches of their designs. Using teacher feedback students make any improvements needed to demonstrate learning by designing a final project in the form of a computer model. Students will then put together finished drawings and renderings for use in their portfolios. Students assemble their best work from this and prior years to continue a design portfolio demonstrating their talent and skill. Students will go beyond a basic portfolio to include customized detail content.
Learning Goals	
Standard(s):	ARCH.08 Maintain a portfolio to document knowledge, skills and experience in architecture. ENG.02.06 Analyze and research between alternate solutions ENG.02.09 Build a prototype from working drawings using appropriate materials. ENG.02.10 Test prototype to defined criteria CADD.07 Create assemblies and views in 3-D format. CADD.10 Maintain a portfolio to document knowledge, skills, materials and experience in CAD. CADD.10.01 Gather educational and work highlights to include in portfolio.
Essential Question(s):	- What conventions exist to ensure all drawings are uniform? - What is the role of creativity and innovation in engineering and Design? - What are the different ways that we can measure the success of a Design project? - What are the pros and cons of using different materials and technologies? - How can Design be used to create more sustainable and efficient transportation systems - What is the role of technology in the future of animation? - How can animation be used to convey complex emotions and ideas?

	● How can engineering be used to create more inclusive and accessible products and services for all people? ● What are common considerations which must be taken into account when designing architectural spaces?
Enduring Understanding(s):	● Design is a creative problem-solving discipline allowing one to express ourselves in unique ways. ● 3D drawings can be beautiful, inspiring, and transformative. ● 3D artists use a variety of software and tools to create their work, and they must have a strong understanding of the principles of 3D modeling and animation ● The understanding of spatial reasoning and geometry required for 3D modeling and animation can be useful in everyday life, from navigating to playing sports. ● 3D modeling and animation is a technical art form that can be used to create engaging educational experiences that can be more effective than traditional methods. ● Architecture, Design and Animation are creative disciplines through which practitioners use their knowledge and skills to design and build solutions to complex problems. ● The creativity and innovation required for engineering can be applied to all aspects of life. ● There are multiple strategies for effectively displaying one's work from physical portfolios to digital portfolios.
Learning Goal(s): *Students will know and will be able to use their learning to:* (Content/ Skills)	**Content:** (Students will know…) ● multiple methods of displaying their work from physical portfolios to digital portfolios ● which elements of a design portfolio are the most important ● strategies for effective communication. ● how to identify and define a real-world problem ● how to conduct research and gather evidence to inform their work. ● how to analyze and interpret complex information. ● how to develop and implement a plan to solve a problem **Skills:** (Students will be able to…) ● use a variety of communication tools and strategies to effectively convey their design concepts to an audience.