Course Title: **Principles of Scientific Visualization**
Course Number: **9400110**
Course Credit: **1**

Course Description:
This course provides students with instruction in the evolution and underlying principles of scientific visualization, including two-dimensional representation of scientific and other forms of data. Included in the content is the use of color and other graphical elements such as vector and bitmap images in different presentation techniques. Students will also learn about the use of charts and graphs in representing data and the software tools used to produce them. The ultimate output of this course is a design portfolio created by the student from a scenario. The portfolio should include a narrative description of the scenario, the approach to data collection, resulting charts and graphs, and an interpretation of each chart/graph. Research references should be cited appropriately. Consideration should be given to having students produce the portfolio using presentation software.

CTE Standards and Benchmarks		NGSSS-Sci
28.0	Describe scientific & technical visualization. – The student will be able to:	
28.01	Define scientific and technical visualization and provide examples of each.	
28.02	Explain the importance of scientific visualization and its applicability to various industries.	
28.03	Provide examples of 2-D and 3D rendered visualizations.	
29.0	Describe the historical significance of scientific & technical visualization. – The student will be able to:	
29.01	Describe the evolution of drawings from cave through perspective drawings to photography, television, and the Internet.	
29.02	Define and describe the elements contained on various types of maps (e.g., road, topographic, aeronautical, weather, concept, and gene).	
30.0	Describe the technological advancements of scientific & technical visualization. – The student will be able to:	SC.912.L.14.4; SC.912.E.5.8; SC.912.P.10.22
30.01	Describe x-ray crystallography and its importance to modern visualization.	
30.02	Compare the differences between microscopes and the types of telescopes (radio and light) relative to their use in scientific visualization.	
30.03	Describe how the advancement of computer technology has impacted scientific visualization.	
30.04	Explain how DNA fingerprinting relates to scientific visualization.	
30.05	Describe magnetic resonance imaging (MRI) and how it benefits from scientific visualization.	
30.06	Describe how geospatial information systems and remote sensing relate to scientific visualization.	

CTE Standards and Benchmarks	NGSSS-Sci
30.07 Define virtual reality and relate it to simulations and holograms.	
31.0 Recognize types of scientific & technical visualization and related careers. – The student will be able to:	
31.01 Describe careers related to scientific visualization that exist in various industries.	
31.02 Describe careers related to technical visualization that exist in various industries.	
32.0 Classify the categories of visualization tools, providing examples of each category. – The student will be able to:	SC.912.N.2.5
32.01 Describe basic computer hardware and software components and characteristics.	
32.02 Interpret the use and application of different types of software programs.	
32.03 Summarize the ethical use of electronic media.	
32.04 Demonstrate basic computer knowledge by writing a proposal for a 3-D animation project to include:	
a) A chart or spreadsheet comparing three software applications in terms of hardware requirements and software cost.	
b) List describing input and output devices chosen and rationale.	
c) Written justification for the proposed solution (2-3 paragraphs).	
33.0 Describe design fundamentals relative to visualization. – The student will be able to:	
33.01 Define the three aspects of design.	
33.02 Describe the three principles of design (balance, rhythm, proportion).	
33.03 Describe the three methods of design (emphasis, unity, and repetition).	
33.04 Define and describe the six elements of design (lines, shapes, color, texture, space, and size)	
34.0 Interpret color and its applications. – The student will be able to:	
34.01 Describe the relationships between additive and subtractive color and their implications to absorbed, reflected, transmissive, transparent, and opaque colors.	
34.02 Describe how mood is communicated using color and give examples.	
34.03 Describe the HSV (Hue, Saturation, Values) Model and its role in color mixing and harmony.	
34.04 Define and explain the use of complimentary color schemes.	

CTE Standards and Benchmarks		NGSSS-Sci
34.05	Describe and give examples of how visual communication uses images and text to convey information and persuade.	
35.0	Discuss vector and bitmap images. – The student will be able to:	
35.01	Define the characteristics of vector images.	
35.02	Describe the advantages of vector images over raster images.	
35.03	Describe the disadvantages of vector images compared to raster images.	
35.04	Compare and contrast line art, complex line art, high detail line art, and colored vector images.	
35.05	Identify the native file format for common software used to create vector images (Corel Draw, Adobe Illustrator, and Adobe Photoshop).	
35.06	Define the characteristics of raster (bitmap) images.	
35.07	Describe the advantages of raster images over vector images.	
35.08	Describe the disadvantages of vector images compared to raster images.	
35.09	Compare the three types of raster images.	
35.10	Explain how the color depth of a raster image pixel affects file size.	
35.11	Define image resolution and explain why it only applies to raster images.	
36.0	Identify effective 2D presentation techniques. – The student will be able to:	
36.01	Identify the fundamental elements used to produce visual aids (images, words, shapes, and color)	
36.02	Explain how theme, focus, balance, weight, and placement affect visual representations.	
36.03	Explain the differences in presentation between demonstration, setting, and product along.	
36.04	Describe common conceptual techniques employed in presentations (picture windows, type specimen, copy heavy, Mondrian, omnibus, multi-panel or cartoon, and silhouette).	
37.0	Describe 2D software applications and their basic functions. – The student will be able to:	
37.01	Identify and describe the purpose of the various tools used in a basic 2D graphics application (select, knife, magnify/zoom, text, fill, pan, eyedropper, gradient blend, and crop).	
37.02	Identify and describe various drawing techniques used in 2D representations, to include Bezier curves, closed and open splines, control points, layering, welding, grouping, desktop, grids and snaps, brushes and brush effects, line thickness, rotation, transparency, and printing).	

CTE Standards and Benchmarks		NGSSS-Sci
	37.03 Create a slide presentation (using software such as Microsoft PowerPoint) that employs backgrounds, master slides, images, movies, slide transitions, internal navigation, and timed sequencing.	
	37.04 Use layout concepts in creating a slide presentation; including use of a common background, the 6-6-6 rule, maximum of two images per slide, appropriate white space, adheres to SAFE design methods, and appropriate text size.	
38.0	Demonstrate effective presentation techniques using appropriate design fundamentals. – The student will be able to:	SC.912.L.15.4; 17.6
	38.01 Design and produce a flyer or brochure about an organism for use in a high school biology or other science program.	
	38.02 Conduct research on a target organism for a flyer or brochure and include parts of the organism, habitat, feeding habits, special adaptations, and role in the environment.	
	38.03 Create two original images of the target organism in 2D software.	
	38.04 Identify the image for use as the dominant element in the layout and include labels and tags.	
	38.05 Sketch the layout of the flyer or brochure and select the appropriate typeface and color theme.	
	38.06 Size images to fit provided in the layout design.	
	38.07 Design a logo for use as an identity mark.	
39.0	Evaluate methods for displaying data using charts and graphs. – The student will be able to:	
	39.01 Recognize different types of charts and their uses and advantages.	
	39.02 Describe the characteristics and uses of bar charts.	
	39.03 Describe the characteristics and uses of a stacked column chart.	
	39.04 Describe the characteristics and uses of a line (x-y) graph.	
	39.05 Describe the characteristics and uses of a pie chart.	
	39.06 Describe the characteristics and uses of a scatter plot.	
	39.07 Describe the characteristics and uses of a histogram.	
	39.08 Identify and describe the different parts of a chart (axis, title, legend, labels).	
	39.09 Describe the basic rules for chart construction.	
40.0	Describe the steps of a design brief. – The student will be able to:	SC.912.N.1.1
	40.01 Describe the problem identification and definition step of producing a design brief.	

CTE Standards and Benchmarks		NGSSS-Sci
	40.02 Describe the plan of work step of producing a design brief.	
	40.03 Describe the literature review step of producing a design brief.	
	40.04 Describe the hypothesis step of producing a design brief.	
	40.05 Describe the data collection step of producing a design brief.	
	40.06 Describe the visualization selection step of producing a design brief.	
	40.07 Describe the self-evaluation step of producing a design brief.	
	40.08 Describe the IDEAL problem-solving process (Identify the problem, Define the plan of work, Explore the problem through research, Act on the possible solution, Look back at the process).	
	40.09 Describe each aspect of the SAFE design process (Simple, Appropriate, Functional, and Economical).	
	40.10 Compare data-driven design to concept-driven design.	
41.0	Describe various organizational and diagramming tools. The student will be able to:	
	41.01 Describe flowcharting and its use in visualization.	
	41.02 Identify and describe the basic flowcharting shapes.	
	41.03 Describe brainstorming and its role in visualization.	
	41.04 Describe the nominal group technique and its role in visualization.	
	41.05 Define and explain the use of Venn diagramming in visualization.	
42.0	Interpret data for use in charts and graphs. – The student will be able to:	SC.912.N1.1; SC.912.P.12.1
	42.01 Compare and contrast the 2D and 3D differences in the Cartesian coordinate system.	
	42.02 Identify and give examples of direct or positive relationships.	
	42.03 Identify and give examples of inverse or negative relationships.	
	42.04 Read data values on charts and graphs and plot a regression line.	
	42.05 Describe and give examples of the following data types:	
	a) Ordinal data	
	b) Nominal data	

CTE Standards and Benchmarks	NGSSS-Sci
c) Scalar quantities	
d) Vector quantities	
e) Qualitative data	
f) Quantitative data	
g) Mean	
h) Median	
i) Mode	
j) Independent variable	
k) Dependent variable	
l) Control	
m) Empirically or computationally derived data	
43.0 Apply data to make an appropriate graph. – The student will be able to:	SC.912.N.1.1, 7; SC.912.L.15.13; 16.2; 17.4, 9; 18.7; SC.912.P.10.8
43.01 Select and create a graph or chart to appropriately illustrate a data set depicting rates of photosynthesis (time in minutes and rate in cubic millimeters).	
43.02 Select and create a graph or chart to appropriately illustrate a data set depicting number of red eyes in fruit flies over generations (frequency of x).	
43.03 Select and create a graph or chart to appropriately illustrate a data set depicting the diet of the coyote in the summer (diet item and percent).	
43.04 Select and create a graph or chart to appropriately illustrate a data set depicting length of cottonwood leaves (length range and quantity).	
43.05 Select and create a graph or chart to appropriately illustrate a data set depicting energy expenditures in the production of corn in 1945 and 1970 (energy input and 1945 and 1970 kcal/m^2 units).	
43.06 Select and create a graph or chart to appropriately illustrate a data set depicting income differences between men and women with different education backgrounds (education level and men and women	
44.0 Recognize digital image formats. – The student will be able to:	
44.01 Explain the difference between native and non-native file formats.	
44.02 Describe the difference between lossy and lossless file compression.	

CTE Standards and Benchmarks		NGSSS-Sci
44.03	Describe the characteristics, advantages, disadvantages, and uses of various image file formats (TIFF, JPEG, GIF, and BMP).	
44.04	Describe the characteristics, advantages, disadvantages, and uses of various audio and video file formats (WAV, AVI, MPEG, MP3, SWF).	
45.0	Summarize basic 3D modeling concepts. – The student will be able to:	SC.912.P.12.6
45.01	Compare and contrast 3D modeling software applications that offer a perspective view, an orthographic view, or a combination.	
45.02	Explain how coordinate systems are used to locate objects in three dimensional space.	
45.03	Describe basic geometric shapes available in 3D modeling software (sphere, cube, cylinder, torus, cone, plane).	
45.04	Describe basic shapes available in 2D modeling software (arcs, ellipses, circles, curve, freehand curves, polygons, splines).	
45.05	Define the parameters used for determining the size, placement, and orientation of a modeling object.	
45.06	Describe the Boolean modeling operations of union, subtraction, and intersection.	
45.07	Describe how extrusion or sweeping techniques transform 2D objects into 3D objects.	
45.08	Describe the lofting technique for creating 3D objects.	
45.09	Describe the revolve or lathe techniques for animating a 2D object and give examples of their application.	
45.10	Describe the scale, rotate, and move actions that comprise the transformation technique for animating a 3D object.	
45.11	Describe the object parameters modified using the deformation technique and provide examples of its use.	
45.12	Describe the copy or clone technique.	
45.13	Describe the mirror technique.	
45.14	Compare and contrast the wire frame and sold viewing tools.	
45.15	Describe basic viewing navigation tools such as zoom, rotate, and panning.	
45.16	Define plug-in and describe how it extends the capability of the modeling program.	
45.17	Describe the export function and its value when producing visualizations.	
46.0	Recognize basic rendering techniques. – The student will be able to:	SC.912.P.10.19; SC.912.E.6.2
46.01	Define rendering and describe its role in 3D modeling.	

CTE Standards and Benchmarks		NGSSS-Sci
46.02	Define texture mapping and describe its role in 2D and 3D modeling.	
46.03	Define UV mapping and describe its role in rendering visualizations.	
46.04	Define bump mapping and describe its role in rendering visualizations.	
46.05	Describe the role of lighting in rendering a 3D visualization.	
47.0	Summarize basic animation techniques. – The student will be able to:	
47.01	Describe how the human brain processes images that make up an animation.	
47.02	Identify the NTSC frame rate.	
47.03	Identify the PAL frame rate.	
47.04	Identify the standard frame rate for motion pictures.	
47.05	Calculate the number of images required a one second of animation.	
47.06	Describe the use of scenes, layers, keyframes, and tweens in animation.	
47.07	Describe stop-action animation.	
47.08	Describe the steps or processes involved in creating a computer animation.	
47.09	Define storyboarding and describe its role in computer animation.	
48.0	Produce a 3D model with animation and rendering. – The student will be able to:	SC.912.N.1.1; 7; SC.912.L.16.7, 15
48.01	Select a topic suitable for animation (e.g., lytic cycle of a T4 bacteriophage virus, a scientific concept or law, replication of a famous experiment, explain how something works, explain a disease) and conduct background research.	
48.02	Create a script and storyboard for the animation.	
48.03	Use a 3D modeling program to build the appropriate graphics to be used in the animation scenes.	
48.04	Create a 3-4 second animation for each scene in the animation.	
48.05	Render each scene and export to an appropriate file format (e.g., AVI, MPEG, MP3, SWF).	
48.06	Integrate the animation scene into a slide presentation using an application such as PowerPoint.	