The mid-term examination will be given from 12:00 PM to 1:15 PM on Tuesday, March 29, 2016. It will cover all material covered through Thursday, March 17 (lecture notes modules 1 through 8 on the class web page). The examination will consist entirely of multiple choice questions. The items listed below are intended to give you an overview of the topics that have been covered, and may therefore have related questions on the examination.

1. What is a suitable definition of computer graphics?
2. What are the fundamental components of a computer graphics system? What components of a traditional personal computer are in each component category?
3. What are the different types of display devices available for computer graphics systems? How do they differ? How do they operate?
4. What are the two types of focusing systems for a cathode-ray tube?
5. What is the positively-charged element in a vacuum tube called? What is the primary negatively-charged element called?
6. How many times per second must a moving image be displayed if flicker (as perceived by a human) is not noticeable?
7. What material is used to coat the inside of a CRT screen? Why is it used?
8. CRTs have been used in two basic types of display systems, vector displays and raster scan displays. What are the essential differences between these systems? Which are most common today?
9. The smallest spot on a CRT screen that can be controlled is called what?
10. What is the name of the data structure used to store the data used by a raster-scan display to control the electron beam(s)? Physically where would the memory containing this data structure be located in a personal computer system?
11. What does the term “aspect ratio” mean?
12. What is meant by “intensity” relative to a CRT? What is the minimum number of usable intensity levels for any CRT?
13. How can a CRT display color images? What are some common techniques for implementing color in a CRT?
14. Suppose a color graphics system uses 24 bits per pixel. For what are these 24 pixels used? Give an example.
15. In a raster-scan system, there are two types of intervals during which the electron beam is turned off while being moved to a new location. Describe these two types of intervals, and where the beam is moving during them.

16. Early graphics systems could produce “snow” or unstable images if the refresh buffer was accessed by the computer at certain times. When would accessing the refresh buffer not cause snow? How do modern graphics systems avoid this problem?

17. Why would a system provide multiple refresh buffers? What benefit could be obtained from using multiple buffers?

18. What does the term “interlaced video” mean? What common system using a CRT uses interlaced video today?

19. What types of displays are used with laptop computers and personal digital assistants? How do these devices work? What variations of these devices are possible?

20. Describe several techniques that might be used to produce three-dimensional images.

21. How are the pixels in a raster-scan system addressed? For example, where might the pixel with coordinates (20,100) be located?

22. How does the CRT in a text-only display system differ from that in a general-purpose graphics system? How does a text-only system operate? Give an example of such a system.

23. How is text processed by a modern graphics system? How is displaying text different from displaying, say, a polygon or a circle?

24. Where, in a modern system, would you typically find compression techniques used to reduce the amount of storage required for an image? Why?

25. List some popular and less popular graphics input devices?

26. How does a mouse operate? That is, what happens as a result of moving the mouse? How is this different from the operation of a joystick?

27. Consider a typical computer generated graphics image. What are the components of this image as far as the computer generation is concerned? There are two “levels” to the answer. The lowest-level answer is individual pixels, but that’s true for any image, including those on television and film. What’s are the components of the other level in computer generated images?

28. What are the fundamental components of a computer graphics system? Two are clearly input and output. What are the others?

29. What is the purpose of the gluOrtho2D function?

30. What does a display callback function do?

31. Most of the objects drawn in an OpenGL program are specified by calls to a “family” of functions. These calls appear between calls to the glBegin and glEnd functions. What “family” of functions are responsible for specifying most of the objects? Why is this called a “family”? What are the differences between the members of this “family?”
32. To what does the phrase “scan line conversion” refer?

33. Under what circumstances might the use of relative coordinates (as opposed to absolute coordinates) be useful?

34. The argument to the glBegin function identifies the kind of object(s) to be produced. Where and how are the possible arguments to glBegin defined? What possible arguments could be supplied (to glBegin) to cause one or more lines to be drawn? How many vertices are required for each line in each case? (Be careful, the answer is not uniformly two!)

35. What are “jaggies?” Under what circumstances might they appear? When would they not appear (exclude antialiasing from your answer).

36. Explain how the digital differential analyzer algorithm operates. Include consideration of the slope in describing the algorithm.

37. What are the advantages (if any) and disadvantages (if any) associated with the DDA algorithm?

38. Bresenham’s algorithm is an improvement over the DDA algorithm. Describe the basic operation of the algorithm. How is it better than DDA?

39. Given a line’s slope and the last pixel position computed for the line, show how Bresenham’s algorithm will select the next pixel position. How many pixel positions are candidates?

40. Various kinds of curves (circles, ellipses, etc.) can be drawn by appealing directly to their mathematical formulas, but this approach has some drawbacks. What are they? Does using polar coordinates and equations solve all of the problems?

41. Describe how Bresenham’s algorithm can be adapted to the display of a circle or ellipse. Is this modified algorithm the same as the “midpoint” algorithm? If not, explain the difference between them. What (in this context) is a “decision parameter?”

42. What is a spline curve? Why are they useful in graphics?

43. Describe, in general terms, the relationship between a pixel (on a display) and a point (the mathematical concept). What problems result from the differences between these?

44. What is a convex polygon? What is a concave polygon? Which of these may not be acceptable to a graphics package (like OpenGL)? Why? What other characteristics of a polygon may make it unsuitable for a graphics package? What is to be done with such polygons?
45. What is the minimum number of OpenGL function calls required in a display function to draw a filled polygon with 6 vertices (assuming it is acceptable to OpenGL) in one color and draw the lines enclosing the polygon in a separate color? For example, how many OpenGL function calls in the display function are required to draw a red-filled hexagon with black edges, like that shown here. Obviously at least four calls are required: one call to \texttt{glColor} to specify the red color for the fill, another call to \texttt{glColor} * to specify the black color for the edges, and at least one call each to \texttt{glBegin} and \texttt{glEnd}.

46. Why is it important to know that a polygon drawn with OpenGL has two faces? How do you identify which face is the front, and which is the back?

47. Is it possible to draw anything in a display function without using \texttt{glBegin} and \texttt{glEnd}? If so, what?

48. Describe the effect of different \texttt{glBegin} parameters when a sequence of vertices is specified. In particular, what is the effect of the \texttt{GL_POLYGON}, \texttt{GL_TRIANGLES}, \texttt{GL_TRIANGLE_STRIP}, \texttt{GL_TRIANGLES}, \texttt{GL_TRIANGLE_FAN}, \texttt{GL_QUADS}, and \texttt{GL_QUAD_STRIP} parameters to \texttt{glBegin}?

49. Describe how to use an array of vertices instead of individual calls to \texttt{glVertex*} to specify a set of vertices that describe an object in OpenGL. Include discussion of enabling any state variables that must be enabled.

50. What are the major differences between the \texttt{glDrawArrays} and \texttt{glDrawElements} functions? For what may these functions be used?

51. What is the difference (in OpenGL) between a bitmap and a pixel map? Which of these would normally be used to store the pattern corresponding to a text character? Which would be used to store an image of a person’s face?

52. Suppose you use the \texttt{glBitmap} function to send a bitmap to the display. In what color with the bits be displayed? Where will the bitmap appear in the window?

53. Under what circumstances would you expect to use 1, 2, or 4 color buffers?

54. For what does the acronym BITBLT stand? What OpenGL functions could be classified as BITBLT operations? Describe, in general, what each of these functions performs.

55. Given an example of some text, describe whether the font being used is proportional or mono-spaced, and serif or sans-serif.

56. Suppose a sample of printed text has 6 lines per vertical inch in an image. How would you describe the size of the font?

57. Compare the advantages and disadvantages of a bitmap font and an outline font. How are outline fonts typically represented (internally)?
58. What is a kern? What is kerning? Give an example.
59. What is a ligature? Give an example.
60. What is a display list (in OpenGL)? Why might a display list be used?
61. By default, a polygon is displayed as a filled region. How could you change this so a polygon is drawn as only a set of lines?
62. What is “stitching?” What could cause this effect? How might you avoid the problem?
63. How many samples per second would be required to capture the information present in a periodic signal that has a maximum frequency component of 5,000 Hertz (or cycles per second)? Who discovered the relationship between samples per second and maximum frequency?
64. In basic scan line conversion, a graphics package determines which pixels are to be used to represent objects (e.g. straight line segments). Normally this process identifies pixels based on the particular display resolution (that is, pixels per vertical and horizontal inch). Why would this process assume a higher resolution than was actually available?
65. How is the apparent intensity of a line with a slope of 1 related to the intensity a line with a slope of 0, assuming each line is drawn using 10 pixels? How might a graphics system compensate for the difference in intensities?
66. What OpenGL function(s) can be used to determine the value of various state parameters, like the current color?
67. Be able to construct the transformation matrices for a translation, a rotation, and a scaling operation. You need not be able to compute trigonometric functions, but you must indicate where they would be used.
68. How can individual transformation matrices be combined to produce a composite transformation matrix? In particular, suppose we want to rotate an object 45 degrees clockwise, translate it by –5 in the x and y directions, and then scale it so it appears twice as large. What would the composite matrix look like?
69. What is a rigid body transformation? Which of rotation, translation, and scaling cannot be used in a rigid body transformation?
70. Be able to identify geometric transformations that might reasonably be performed by OpenGL BITBLT operations. What other OpenGL functions might be useful in performing geometric transformations?
71. Describe how to construct a GLUT menu that contains three main menu items, two of which are submenus each containing four items. How are menu items “activated?” What happens when a menu item is activated?
72. How would you use a GLUT timer to periodically cause a change in the image displayed by the display callback function? What happens when a GLUT timer expires?