

# CSE 3541 Sample Exam Questions

Autumn 2021, Prof. Roger Crawfis

## Event-based Programming, Render Loop, Handling Input and C# events

1. Who typically calls your function to render an object?
  - a. The programmer
  - b. The end-user
  - c. The Game Engine
  - d. The Operating System
2. (essay) Detail the steps taken in a render loop
3. A keyboard key press can only have one callback when using C# events?
  - a. True
  - b. False
4. The format used for any event in Unity is:
  - a.  $\text{Func}\langle T_1, T_2 \rangle$
  - b.  $\text{Action}\langle T \rangle$
  - c.  $\text{Action}\langle \text{InputValue} \rangle$
  - d. Anything
5. How does one stop a game in Unity (and most other game engines)?
  - a. Unity will stop it when the game finishes
  - b. The programmer must write code to quit the game.
  - c. The user is responsible for stopping the game
  - d. By using a Main Menu
6. Which of the following is not part of the Render Loop?
  - a. Handling input
  - b. Initializing the scene
  - c. Rendering each model
  - d. Applying physics
  - e. Handling custom code in an Update method
  - f. Setting triggers to isActive
  - g. Loading models and textures
7. (code) Create a C# event called `DamageReceived` that needs a float on the amount of damage and a reference to the enemy `GameObject` that dealt it. Also write two different methods that subscribe to the event and show the code to subscribe to the event.

## Points, Vectors and Coordinate Frames

8. (essay) What do we mean by homogenous coordinates?
9. Any three points define a coordinate system
  - a. True
  - b. False
10. Which of the following are **needed** to define a coordinate frame in three-dimensions?
  - a. A transform matrix

- b. 3 arbitrary vectors
  - c. 3 orthogonal vectors
  - d. 3 independent vectors
  - e. A point
  - f. An axis
  - g. A camera
11. (essay) Describe orthonormal basis vectors. When and why are they are desirable?
12. The following defines a coordinate frame using homogenous coordinates:  $(5,5,0)$ ,  $(-4,2,0)$ ,  $(-4,-2,0)$ .
- a. True
  - b. False
13. The following defines a coordinate frame using homogenous coordinates:  $(3,1,1)$ ,  $(0,1,0)$ ,  $(-1,0,0)$ .
- a. True
  - b. False
14. Given the coordinate frame with an origin of  $(2,3)$  and basis vectors  $(3,1)$  and  $(1,3)$ . Where are the following points, defined in this coordinate system, on the cartesian plane?
- a.  $(2,3)$
  - b.  $(5,1)$
  - c.  $(2,7)$
  - d.  $(3,6)$
  - e.  $(0,0)$
15. Given the coordinate frame with an origin of  $(2,3)$  and basis vectors  $(3,1)$  and  $(1,3)$ . A point  $(5,4)$  in this coordinate system is specified in this coordinate system as:
- a.  $(2,3)$
  - b.  $(5,4)$
  - c.  $(2,7)$
  - d.  $(0,0)$
16. (essay) What is the difference between a point and a vector? Why is this important?
17. The cross product can be used to determine if two vectors are pointing in similar directions
- a. True
  - b. False
18. The cross product can be used to determine a coordinate frame given two non-linear vectors.
- a. True
  - b. False

## Transforms and Transform Matrices

19. Which of the following are not rigid body transforms?
- a. Shear
  - b. Scale
  - c. Rotate
  - d. Translate
  - e. Mirror
  - f. Squish

20. (formula) Show the three-dimensional rotation matrix that rotates  $\theta$  radians about the y-axis.

21. Given a point P as a column vector. Suppose that we want to first translate the point by the translation matrix T and then rotate by the rotation matrix R. The overall transform can be written as  $T \cdot R \cdot P$ ?

- a. True
- b. False

22. The following matrix does which of these:

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 5 & 3 & 1 \end{bmatrix}$$

- a. Rotates in x by  $\cos\theta = 5$  and then y by  $\sin\theta = 3$ .
- b. Translates by (-5,3)
- c. Translate by (5,3)
- d. None of the above

23. The following matrix does which of these:

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 5 & 3 & 0 \end{bmatrix}$$

- a. Rotates in x by  $\cos\theta = 5$  and then y by  $\sin\theta = 3$ .
- b. Translates by (-5,3)
- c. Translate by (5,3)
- d. None of the above

24. Any sequence of rotations can be represented by a single rotation matrix.

- a. True
- b. False

25. Any sequence of rotations is equivalent to the same sequence in reverse order.

- a. True
- b. False

26. Translating all points of a model is equivalent to translating its coordinate system or origin.

- a. True
- b. False

27. 3D translation, scaling, and rotation can all be represented using 3x3 matrix multiplications.

- a. True
- b. False

28. Any combination of translation, rotation, and scaling operations on a 3D point in homogeneous coordinates can be represented using a 4x4 matrix.

- a. True
- b. False

## Graphics and Rendering

29. (essay) Write the definition of a quad using 2 triangles in terms of how Unity would represent it.

30. (essay) What is a lightmap and how is it used?

31. (formula) Write the lighting equation developed by Phong.

32. Ambient lighting occurs in a dark room

- a. True

- b. False
- 33. Diffuse lighting on the surface changes as the camera or viewer moves.
  - a. True
  - b. False
- 34. Specular lighting on the surface changes as the camera or viewer moves.
  - a. True
  - b. False
- 35. Which lighting term uses the vector pointing towards the camera?
  - a. Ambient
  - b. Diffuse
  - c. Specular
  - d. None of the above
  - e. All of the above
- 36. Shadow mapping requires rendering the scene at least twice
  - a. True
  - b. False
- 37. Global illumination considers the light
  - a. Coming from any light source
  - b. Bouncing off of any diffuse surface
  - c. Emitted from any object with emissive properties
  - d. B and D above
  - e. All of the above
- 38. Baked lighting is limited to 4 light sources
  - a. True
  - b. False
- 39. Light Probes are spheres within the scene
  - a. True
  - b. False
- 40. (list) List the various types of light sources covered in class.
- 41. Ambient occlusion is based on the lights within the scene.
  - a. True
  - b. False
- 42. (list) What are the (major) components of a PBR material in Unity?
- 43. A spotlight can produce both an umbra and a penumbra.
  - a. True
  - b. False
- 44. (essay) Explain why percentage closer filtering is needed.
- 45. A geometric model can only have 1-set of texture coordinates
  - a. True
  - b. False
- 46. (essay) Explain the “missing W”. [image source: cj from Instagram]



## Hierarchical Models

47. The point (0,0,0) in local space of a model must also be (0,0,0) in world space.
  - a. True
  - b. False
48. Deep hierarchies are expensive as the resulting model must go through a sequence of transforms.
  - a. True
  - b. False
49. Translating the parent of a hierarchy will translate all of the children, but not their children.
  - a. True
  - b. False
50. Rotating a child object will rotate its parent
  - a. True
  - b. False

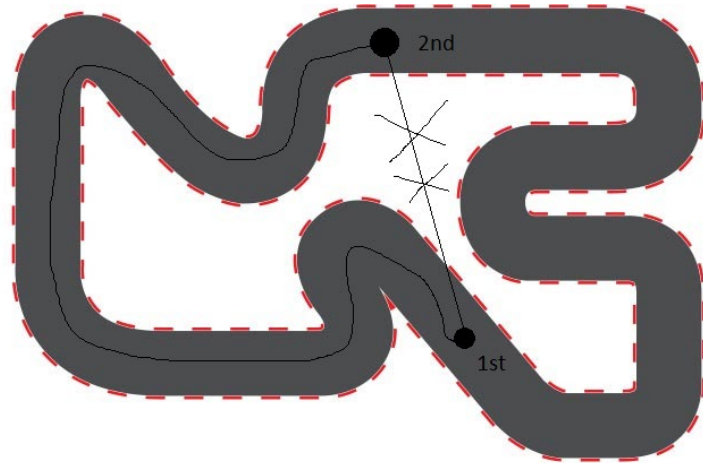
## Physics-based Animation and Rigid Bodies

51. Given enough force, a rigid body will flatten
  - a. True
  - b. False

## Behavioral Animation

52. (essay) What is the key difference between A\* and Dijkstra's algorithm?
53. Breadth-first is slow but will provide the shortest path.
  - a. True
  - b. False
54. (essay) Briefly describe how you would use a finite-state machine to control a prey as used in your Lab5.
55. Consider the three forces that control flocking: separation, alignment, and cohesion. Removing any of the three forces will change the motion of the flock.
  - a. How is the flocking motion affected if you remove only the separation force?
  - b. How is the flocking motion affected if you remove only the alignment force?
  - c. How is the flocking motion affected if you remove only the cohesion force?

56. (essay) Suppose you are working on a kart racing game and plan to implement a projectile similar to the infamous blue shell from Mario Kart. When fired, the blue shell moves towards the player in first place, but it must remain on the racetrack while doing so. For example, in the figure below, the shell fired from the player in second place cannot move on the line (with x's over it) that leads directly to the player in first place since the line goes out of the bounds of the racetrack. A manually drawn curve in the image shows valid motion for the shell. Note that the player in first continues to move after the shell is fired. **Describe at least two ways you could implement the motion of the blue shell, then explain which of the two methods you would actually implement and why you would choose that one.**



57.

## Interpolation, Splines and Curves

58. A cubic polynomial fitting a curve can be defined by 3 data points
- True
  - False
59. (essay) Given 1D points  $p$ ,  $q$ , and  $r$ , draw points from the result of linear interpolation between  $p$  and  $q$  for  $u$  values of 0, 0.25, 0.5, 0.75, and 1. Then do the same for linear interpolation between  $q$  and  $r$  for  $u$  values of 0, 0.25, 0.5, 0.75, and 1. Assuming each interpolated point is the location of an object in one of ten frames of animation, describe the motion of the object as it moves from  $p$  to  $q$  then  $q$  to  $r$ .



60.

## Rotations and Quaternions

61. (essay) Describe gimbal lock and why it may be a problem.
62. (essay) If we rotate a model from position  $i$  to position  $i+1$ , what is the problem of interpolating the models between these rotated positions? How might you solve it?
63. (formula) Given a point,  $p$ , how do we rotate it with quaternions?
64. Which of the following statements about rotation representations are true? (circle all that apply)
- a. A single rotation matrix requires less storage space than a single quaternion.
  - b. Quaternion multiplication requires less computation than rotation matrix multiplication.
  - c. Quaternion rotation is equivalent to the axis-angle rotation.
  - d. Rotation matrices are more intuitive to use than quaternions.
  - e. The axis-angle representation suffers from the Gimbal lock problem.
65. Quaternions are subject to gimbal lock.
- c. True
  - d. False
66. The identity quaternion,  $q$ , has the following properties (circle all that are true)
- e.  $q^{-1} * q = 1$
  - f.  $q * q^{-1} = 1$
  - g.  $q = [1, (0,0,0)]$
  - h.  $q = [1, (1,1,1)]$
  - i.  $||q|| = 1$
  - j.  $q = [0.5, (.5, .5, .5)]$
67. (formula) Given an axis,  $\vec{v}$ , and an angle,  $\theta$ , show the quaternion(s) that will accomplish this.
68. Euler angles are much easier to read and hence are used in most GUI's.
- k. True
  - l. False
69. Unity uses Euler angles for all rotations.
- m. True
  - n. False