Introduction and Game Engine

1. Write at least five names of game genres.
   Action, adventure, action-adventure, RPG, strategy, simulation, rhythm, survival, sports
2. What does FPS stand for?
   First person shooter
3. Write at least two distinct features of FPS game genre.
   a. Focuses on combat involving projectile weapons, such as guns, and missiles
   b. Player is "behind the eyes" of the game character in a first person perspective
4. Write at least two benefits that you gain when using a game engine for your game development.
   Reusable software components and access to a suite of visual development tools
5. What do you mean by "Platform-independent" game engine?
   Able to be used to develop a game that's compatible with multiple game systems with little to no porting work required.
6. Write three types of game engine. To which game type does Unity belong?
   a. Roll-your-own
   b. Mostly-ready
   c. Point-and-click (Unity)
      https://csns.calstatela.edu/site/f18/cs4555-1/item/6645550
7. Write at least three names of Open Source Game engines.
   Crystal Space, Delta3D, Game Blender, Irrlicht, The Nebula Device, Ogre3D, Open Dynamics Engine, Panda3D

Basic Math for Game Programming (see "Basic Math for Game" lecture note)

Cross Product

$$\mathbf{a} \times \mathbf{b} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ a_x & a_y & a_z \\ b_x & b_y & b_z \end{vmatrix}$$

1. Let vector v=(2,4,4). Normalize it.
   |v| = sqrt(4+16+16)=6 (you get the values from squaring the coordinates in the vector)
   $\hat{v}$= (2/6,4/6,4/6)=(0.33,0.66,0.66)
2. Let two vectors v and w be v=(2,2,1) and w=(1,-2,0). Calculate their dot product and cross product.
   Dot product: 2(1)+2(-2)+1(0) = -2
   Cross product: (0+2)-(0-1)+(-4-2) = <2,1,-6> or 2i+1j-6k

$$\vec{a} \times \vec{b} = \begin{vmatrix} a_2 & a_3 \\ b_2 & b_3 \end{vmatrix} \vec{i} - \begin{vmatrix} a_1 & a_3 \\ b_1 & b_3 \end{vmatrix} \vec{j} + \begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix} \vec{k}$$

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$

3. Given two vectors v=(1,0,0) and w(0,1,0). Calculate their dot product. What is the smaller angle between these two vectors?
   Dot product: 1(0)+0(1)+0=0
   |v|=1
   |w|=1
   ^v=(1,0,0)
   ^w=(0,1,0)
   cos(pheta)=^v * ^w=0 (* = dot product)
   pheta = 90 degrees = 1.57 rad (this is answer to second question)

4. Given two points A=(-4,5) and B=(2,-2). Define a line passing through two points using the parametric line equation.
   *L(t) = C + **bt***
   where ***b** = (B-C)*
   L(t) is a specific point on the line at *t*.
   b=(B-A)=(6,-7)
   L(t)=(-4,5) + (6,-7)t = (-4+6t, 5-7t) where $-\infty \leq t \leq \infty$
5. Write a plane equation defined by the three points (1,2,0), (2,0,-1), and (3,-2,1). What is the normal **n** of this plane?
   a = p2-p1, **b** = p3-p1, **n** = **a** x **b**
   a = (2-1,0-2,-1-0) **b** = (3-1,-2-2,1-0)
   a = (1,-2,-1) **b** = (2,-4,1)
   a x **b** = (-2-4)-(1+2)+(-4+4) = -6-3+0 = -6i - 3j

   P(s,t) = C + s**a** + t**b**
   P(s,t) = (1,2,0) + s(1,-2,-1) + t(2,-4,1)
   P(s,t) = (1+s+2t, 2-2s-4t, -s+t)

6. Let S=(1,0,2) and V=(2,1,-1). Find the point at which the line P(t) = S+tV intersects the plane L=(a,b,c,d) = (1,1,0,5).

Unity Game Engine Questions

1. Write at least two distinct features of Unity game engine compared to other Game Engines.
   Built in assets through unity asset store.
   -creating prefabs to easily replicate across different scenes
   -cross platform
   -able to edit values while game is running paused to see resulting changes instantly
2. Define “Assets”. Give examples of art assets.
   Representation of any item that can be used in your game or project. Art assets: 2D image, 3D model, material, animation, particle system
3. Define “Prefabs”.
   Instance of an object that has a consistent set of properties
4. What does HUD stand for?
   Heads up display
5. What does NPC stand for?
   Non-player character
6. Define NavMesh Baking.
   The process of creating a NavMesh from the level geometry is called NavMesh Baking.
7. What is the main difference between Start() and Update() functions of MonoBehavior class?
   Start is called once when the object becomes active. Update is called every frame.
8. What are the three types of lights in Unity? Which light is like the Sun in real world?
   Point, spot, directional. Directional is like the sun.
9. In the following code segment, what does [SerializeField] attribute do?
   [SerializeField] private float speed;
   Speed can be edited in Unity’s editor but can’t be touched by other scripts
10. What does the code segment do?

```
using UnityEngine;
using System.Collections;
public class Unknown : MonoBehaviour {
  public float speed = 3.0f;
  void Update() {
    transform.Rotate(0, speed, 0);
  }
}
```

    The transform is rotated along the y axis by the speed variable every frame.
11. What does the code segment do?

```
transform.Rotate(0, speed, 0);
transform.Rotate(0, speed, 0, Space.World);
```

    First line rotates transform along local axis while second line rotates it around the world axis.
12. What is raycasting? Describe when (for what purpose) you use it for your homework.
    Use of ray-surface intersection tests to solve a variety of problems in computer graphics and computational geometry. It’s used to handle shooting and to determine what’s in front of an agent.

13. What is the main difference between a coroutine and a function? When do you need to use coroutines?
    A function can't be used to trigger a sequence of events over time while coroutines are able to do that.
14. What is the return type of a coroutine?
    IEnumerator and the yield keyword in the return statement
15. When you invoke a function, you invoke it directly using its function name in your program. How do you invoke a coroutine?
    StartCoroutine() function
16. Which keyword causes a coroutine to temporarily pause, handing back the program flow and picking up again from that point in the next frame?
    WaitForSeconds()
17. Write the execution order of the following function. Give number 1 through 5. Also write when each function will be executed.
    Start() 2 - Initialization
    Awake() 1 - Initialization
    OnGUI() 5 - GUI Rendering
    Update() 4 - Game Logic
    OnTriggerEnter() 3 - Physics
    https://docs.unity3d.com/Manual/ExecutionOrder.html
18. Assume that you have the following code segment in Sample.cs. What does it do? What happen if we use Destroy(this); instead?
    Destroy(this.gameObject);
    This only removes the script. This.gameobject DESTROYs the object the script is attached to itself
19. The following code segment instantiate a fireballPrefab object. Why do we need "as GameObject"?
    private GameObject fireballPrefab;
    _fireball = Instantiate(fireballPrefab) as GameObject
    Without it, it will instantiate it as a generic Object type.
20. Describe the main difference between textures and materials.
    -TEXTURES ARE BASIC IMAGES
    -MATERIALS CONTAIN THE CHARACTERISTICS AND DETAILS OF WHAT AN OBJECT SHOULD LOOK LIKE, AND EVEN TAKES TEXTURES AS PARAMETERS TELLING WHERE THE TEXTURES GO
21. What is the size constraint for texture images in Unity?
    They have to be sized in powers of 2.
22. For texture mapping, each vertex/point of your 3D model is associated with (u,v) texture coordinate that indicates a pixel location in the texture map.
    a. (u,v) coordinate range such that the u coordinate ranges from 0 to 1 from left to right, and the v coordinate ranges from 0 to 1 from bottom to top. True or False?
       T
    b. It is also legal to use texture coordinates (u,v) that go outside this range; you can have negative values, for instance, or number higher than 1. True or False?

T

c. (u,v) values associated with each vertex can be scaled and translated. True or False?
   T

23. Assume that you have a plane with a material whose Tiling is set as (4,6) and Offset is set as (1,1). How does the texture image appear on the plane?
    4 tiles per X axis and 6 tiles per Z axis
24. Write two texture wrap modes provided by Unity.
    CLAMP AND REPEAT
25. Write two texture filter modes provided by Unity.
    POINT, BILINEAR, TRILINEAR - https://docs.unity3d.com/ScriptReference/FilterMode.html
26. Describe one scenario where texture minification or magnification is required.
27. What are mipmaps? When is it useful?
    Prefiltered texture maps of decreasing resolutions. Helps texture look much smoother than filtering alone when it's minified
28. What is the anisotropic filtering? When do you need it?
    MAKES TEXTURE LOOK BETTER AT SHALLOW ANGLEs. USUALLY USED ON FLOORS, GROUND, AND ROAD TEXTURES TO MAKE THEM LOOK BETTER.
29. What does the code segment do?
    Value = Input.GetAxis("Horizontal");
    Returns value of mouse horizontal/ y axis ?
30. What are 4 pieces of the Unity Navigation System?
    NavMesh, NavMesh Agent, NavMesh Obstacle, Off-Mesh Link
31. For NavMesh Obstacle, we can turn on or off "Carve" option. When should we turn it off?
    When the obstacle is constantly moving, like a car.
32. If both NavMesh Agent and Rigidbody (non-kinematic) are active at the same time, you have race condition. True or False?
    True
33. You don't need to add physics colliders to NavMesh Agents for them to avoid each other. True or False?
    True
34. NavMesh Agent and Animator without Root Motion can cause race condition. True or False?
    False
35. NavMesh Agent and NavMesh Obstacle do not work well. True or False?
    True
36. What does the following code segment do?
    NavMeshAgent agent = GetComponent<NavMeshAgent>();
    Agent.destination = goal.position;
    Set the destination point for the agent
37. Every GameObject has a Transform. Is this statement True or False?
    True
38. The position, rotation and scale values of a Transform are measured relative to the

Transform's parent. Is this statement True or False?
TRUE

39. If the Transform has no parent, the properties are measured in world space.
    TRUE
40. In Unity, X, Y, and Z axes in 3D space are color-coded. What is the designated color for each axis? Is this statement True or False?
    TRUE, RGB = XYZ / RED GREEN BLUE
41. What are global and local coordinates? Define them using the term "Parenting".
    Global coordinates are coordinates based on the entire world space, while local coordinates are coordinates based on the parent object's space.
42. What does the following code segment do?

```
void Update() {
    Vector3 targetDir = target.position -
    transform.position;
    angleBetween = Vector3.Angle(transform.forward,
    targetDir);
}
```

    Calculating "target" and "this gameObject's" front facing angles difference
43. List at least three Unity primitive colliders.
    BOX COLLIDER, SPHERE COLLIDER, CAPSULE COLLIDER
44. What is a mesh collider? When is it useful to use? Why does Unity discourage to use it?
    It would be more expensive to calculate collider for mesh collider
45. What is a trigger object?
    A collider configured as a Trigger does not behave as a solid object and will simply allow other colliders to pass through. and emit OntriggerEnter/ Stay/ Exit events
46. What are Static Collider, Rigidbody Collider, and Kinematic Rigidbody Collider?
    Static Collider - This a GameObject that has a Collider but no Rigidbody. (Does not react to physics engine)
    Rigidbody Collider- This is a GameObject with a Collider and a normal, non-kinematic Rigidbody attached. (Reacts to physics engine)
    Kinematic Rigidbody Collider - This is a GameObject with a Collider and a kinematic Rigidbody attached (ie, the IsKinematic property of the Rigidbody is enabled). (Reacts to physics engine, and controlled by scripts, like an automatic door)
47. Write main differences between trigger object collisions and non-trigger object collisions.
    Trigger object calls the ontriggerenter while nontrigger calls the oncollision enter?
48. Complete the following collision action matrix. If collision messages are sent upon collision between two objects with corresponding components, mark "C". If trigger messages are sent upon collision between two objects with corresponding components, mark "T". Otherwise, leave it as blank.

	Static Collider	Rigidbody Collider	Kinematic Rigidbody	Static Trigger Collider	Rigidbody Trigger Collider	Kinematic Rigidbody Trigger

						Collider
Static Collider		C			T	T
Rigidbody Collider	C	C	C	T	T	T
Kinematic Rigidbody Collider		C		T	T	T
Static Trigger Collider		T	T		T	T
Rigidbody Trigger Collider	T	T	T	T	T	T
Kinematic Rigidbody Trigger Collider	T	T	T	T	T	T

49. If you want you object to react to physical collision with other objects and the game world, you must add a RigidBody component. Is this statement True or False?
    T
50. The player's CharacterController will generate a trigger event when colliding with a trigger object. Is this statement True or False?
    T
51. A character controller cannot walk through static colliders in a scene. Is this statement True or False?
    T
52. Character Controller component gives the character a simple, cylinder collider that is always upright. Is this statement True or False?
    F
53. If the player has a CharacterController component, the player character is fully influenced by Game Physics. Is this statement True or False?
    F
54. Describe how Unity allows us to set the collision system to ignore (filter out) some collisions.
    Use IgnoreCollision, supplying the respective colliders:
    Physics.IgnoreCollision(gameObject.collider, anotherGameObject.collider);

Unity Game Engine questions (for Extra Credits since these are not from topics for the midterm scope)

1. What is the difference between Update() and LateUpdate() functions?
   GETS CALLED AFTER UPDATE() , useful for following camera, which translate only after the update movement has complete
2. What does the following code segment do?

```
void Start() {
  _rotY = transform.eulerAngles.y;
  _offset = target.position - transform.position;
}
void LateUpdate() {
  float horInput = Input.GetAxis("Horizontal");
  if (horInput != 0) {
    _rotY += horInput * rotSpeed;
  } else {
    _rotY += Input.GetAxis("Mouse X") * rotSpeed * 3;
  }
  Quaternion rotation = Quaternion.Euler(0, _rotY, 0);
  transform.position = target.position - (rotation * _offset);
  transform.LookAt(target);
}
```

3. Consider the following code segment.

```
void Update() {
  …
  Vector3 movement = Vector3.zero;
  float horInput = Input.GetAxis("Horizontal");
  if (horInput != 0) {
    movement.x = horInput;
    Quaternion tmp = target.rotation; // save the target's angle
    target.eulerAngles = new Vector3(0, target.eulerAngles.y, 0);
    movement = target.TransformDirection(movement);
    target.rotation = tmp; // recover the target's angle
    transform.rotation = Quaternion.LookRotation(movement);
   …
}
```

   a. What does the following line do?
      target.eulerAngles = new Vector3(0, target.eulerAngles.y, 0);
   b. What does the following line do?
      Transform.rotation = Quaternion.LookRotation(movement);
   c. What does the program do?

Collision Detection

1. Overlapping test and intersection test are two basic techniques for collision detection. Describe what they are. Why do we need intersection test?
   a. Overlap: detects whether a collision has already occurred. Test every pair of objects to see if they overlap
   b. Intersection: predicts whether a collision will occur in the future
2. There are two general issues in collision detection.
   a. If collision detection process is performed for the original model geometry, it is highly inefficient and expensive. Write at least two ways that solves this issue.

Simplified geometry and minkowski sum

b. If a collision process yields O(n^2) time complexity, it is highly inefficient and expensive. Write at least two ways to improve time complexity.
Partition space and plane sweep algorithm

c. What does Unity provide to solve one or both of these issues.?

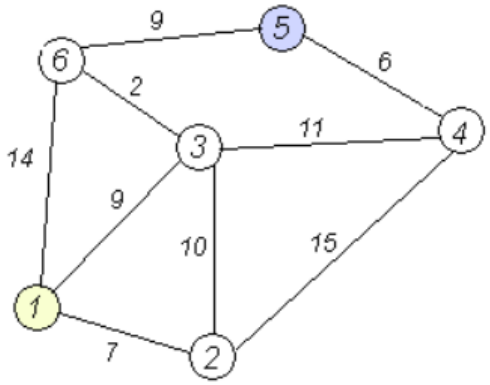
3. Compute the time of collision for two spheres, each of radius 0.25, that starts at t=0 at the position (0,0) and (1,1) respectively, and both end up at (1,0) at t=1.
4. Draw the Minkowski sum of a circle and a triangle.
5. Let's assume that the player character is moved on a Terrain map (triangular mesh) whose y-axis is for height. Given the identified triangle with vertices at (1,0,0), (0,0,1) and (0,1,0) for the collision, a character's feet are currently located at (0.2,0,0.2). Update y-value of the feet such that the character's feet are on the plane to avoid collision.
6. Given a triangle with vertices at (0,0,0), (1,0,0) and (0,0,1), calculate the Barycentric coordinates of the points (0.5,0,0) and (1,0,1).
7. In games, collisions between characters are not usually very precise, as often times the arm or leg of one character will penetrate another character. If precise collision detection is employed, what problems or issues might arise? What advantage does modeling character-character collisions with spheres or cylinders offer?

AI and Pathfinding Algorithms

1. Write three ways to represent a search space for pathfinding algorithm.
Grids
Waypoint graphs
Navigation meshes
2. Write at least three reasons that Navigation mesh representation is superior to Waypoint graph representation.
    a. Unlike Waypoint move from point to point, navmesh able to move freely within mesh area
    b. Better at chasing player, without going point by point
    c. Building AI pathfinding algorithms
3. For every algorithm covered in the class (Breadth-First, Best-First/Greedy, A*, and Dijkstra), answer the following questions:
    a. Is the algorithm an exhaustive or a heuristic algorithm?
        i. Breadth-First: exhaustive
        ii. Greedy: heuristic
        iii. A*: heuristic
        iv. Dijkstra: exhaustive
    b. Does the algorithm always find the optimal path?
        i. Breadth-First: Yes
        ii. Greedy: No
        iii. A*: Yes
        iv. Dijkstra: Yes
    c. Is the algorithm a complete algorithm?

i. Breadth-First: yes
ii. Greedy: no
iii. A*: yes
iv. Dijkstra: yes

4. Why is A* preferred over Breadth-First and Greedy algorithm?
5. Consider the following map.



Heuristic function h(n):

h(1)=15
h(2)=15
h(3)=10
h(4)=5
h(5)= 0
h(6)= 7

Node 1 is the initial (departure) node and Node 5 is the goal (destination) nodes. The step cost between two nodes is given as an edge cost in the figure. The heuristics **h(n)** (cost from each node **n** to the goal) are given next to the graph. The task is to find a path to the goal node from the initial node. Write a path found by each algorithm (BFS, Greedy, A*, Dijkstra algorithm). Is the path optimal?