INSTITUTE OF TECHNOLOGY TRALEE

WINTER EXAMINATIONS AY 2019-2020

MODULE TITLE
Games Development

Module Code SWDV 61007
CRN 43978

External Examiner(s): xxxxxxxxxxxx

Internal Examiner(s): Dr. Robert Sheehy

Duration: 2 Hours

Instructions to Candidates: Please answer 4 questions

Question 1

(a) Mathematics and in particular vector mathematics would be used throughout games. Given the following situation:

```
pickpocket.transform.position = new Vector3(-9,10,1);
mark.transform.position = new Vector3(-11,7,-5);
pickpocket.transform.forward = Vector3.Normalize(new Vector3(-2,-10,-25));
mark.transform.forward = Vector3.Normalize(new Vector3(-6,-6,-17));
```

(i) Derive the vector "pickpocket_to_mark"

(2 Marks)

(ii) How far is the pickpocket from the mark?

(2 Marks)

(iii) Calculate the vectors

- `pickpocket.transform.forward` and
- `mark.transform.forward`.

(3 Marks)

(iv) Determine, by appropriate use of a scalar dot product, whether the pickpocket is behind the mark.

(3 Marks)

(v) Determine, by appropriate use of a scalar dot product, whether the pickpocket is facing the mark.

(3 Marks)

(b) Frame rates are a key consideration when implementing movement, and in particular keeping movement Frame Rate Independent

(i) What are the physical rules governing motions that are used to ensure Frame Rate Independence?

(3 Marks)

(ii) Illustrate (code or pseudo code) how Frame Rate Independent motion could be implemented

(4 Marks)

(iii) Illustrate how forces could be applied to an object, giving justification with reference to the appropriate physics formula.

(2 Marks)

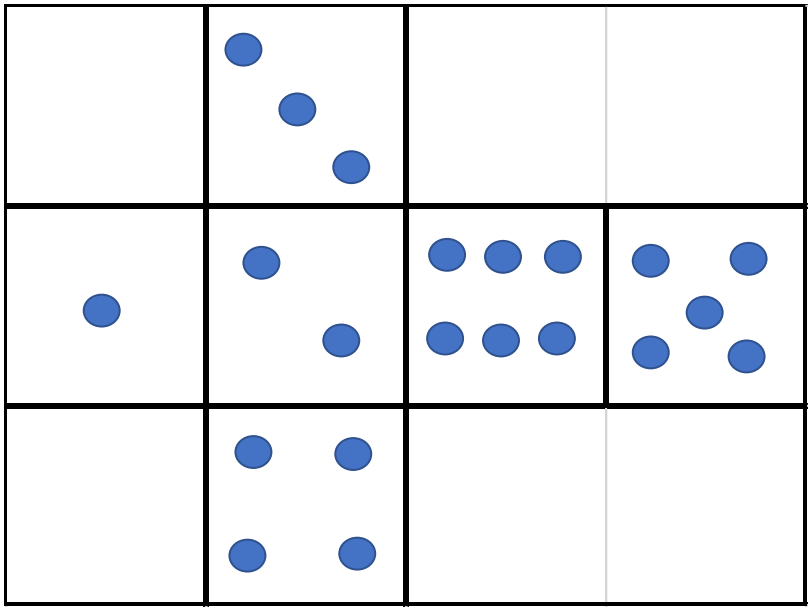
(iv) Describe how the following could be implemented.

- Gravity
- Wind Resistance
- Explosions

(3 Marks)

Question 2

To model a die for a game, a cube is textured with the following bitmap, ensuring that opposite sides always add to 7.



(a) State two of the conventions used in model definition, and explain the rationale behind them.

(5 Marks)

(b) Derive vertex and index lists for the model of this die.

(9 Marks)

(c) What is texturing and how is it implemented?

(2 Marks)

(d) Derive the texture co-ordinates and indices for the faces illustrated above.

(9 Marks)

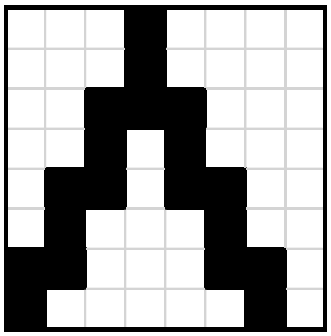
Question 3

(a) BIOT was used to determine collisions between sprites.

(i) What was BIOT?

(1 Mark)

(ii) The following sprite would have been stored in numeric form, derive these numbers.



(3 Marks)

(iii) Draw the sprite represented by the following bytes.

192,112,28,7,28,112,192,0 **(3 Marks)**

(iv) If the top left pixel of the sprite in part (ii) was placed at (52,102) and the sprite from part (iii) was placed at (56,98), illustrate on graph paper whether BIOT would detect a collision between them.

(3 Marks)

(b) Axis Aligned Bounding Boxes (AABB) are not an accurate a means of detecting collisions.

(i) Describe why AABB's are not accurate and outline their use in collision detection within a modern games engine.

(5 Marks)

(ii) The following table outlines the positions and ranges of the AABB's for 3 objects. Apply the Sort and sweep algorithm to determine if a collision has occurred.

Object Number	x			y			z		
1	55	±	5	132	±	5	201	±	2
2	70	±	3	140	±	5	199	±	1
3	60	±	2	78	±	10	209	±	8
4	62	±	6	125	±	4	189	±	7

(10 Marks)

Question 4

(a)

(i) What function would Artificial Intelligence (AI) serve in a typical modern game?

(2 Marks)

(ii) Finite State Machines (FSM) are one of the techniques used to implement AI in some games. Discuss the role of case based programming when implementing these, referring, in particular, to the following. Please provide code snippets to clarify any points made.

- Sensing Stage

(2 Marks)

- Thinking Stage

(3 Marks)

- Action Stage

(3 Marks)

(iii) Outline the advantages and disadvantages of FSMs.

(2 Marks)

(iv) Describe Markov models and Hierarchical FSMs. What advantages do these have over classical FSMs?

(2 Marks)

(b) The AI used in games like Chess and Draughts would be seen as a Search Problem

(i) How do Search Problems work?

(3 Marks)

(ii) What is the *Utility Function?*

(1 Mark)

(iii) What is an *Evaluation Function*?

(1 Mark)

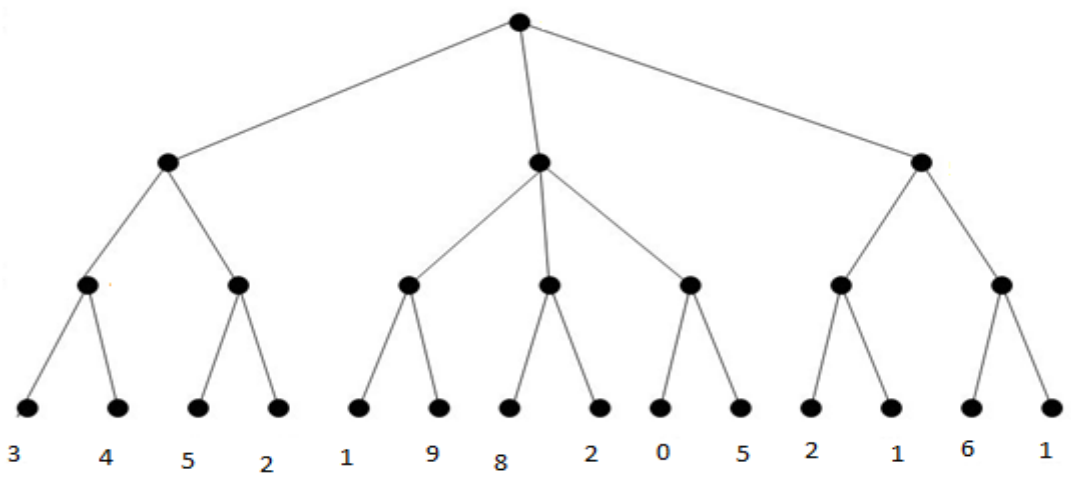
(iv) Explain how the Evaluation function could be used in a search tree problem.

(2 Marks)

(v) Compare the practicality of the implementations of the AI for Tic-Tac-Toe against a game like chess or draughts. What are the main issues in producing reasonable AI? How could the performance be improved etc.

(2 Marks)

(vi) Apply the Min/Max algorithm to determine which is the correct next move, show the full tree with filtered weights in your answer.



Question 5

(a) Contributing to, and managing, a group project can be a challenging problem. Describe workflow of a typical setup for a project on a public Git repository. Please address the following.

- Initial Setup.

(4 Marks)

- Typical Work session.

(4 Marks)

- Management of project after completion of work session.

(4 Marks)

(b) Inheritance is one of the core concepts of Object Orientated Programming (OOP).

- What is inheritance?

(1 Mark)

- Give an example of how inheritance may be used in game development.

(2 Marks)

- What is polymorphism? Give an example of where it was used in the class project this year or a similar example for game development.

(3 Marks)

A Unity script, by default, inherits from the Monobehaviour class.

- Discuss, with examples, what that means for typical unity scripts.

(3 Marks)

- Discuss the ways that game objects can communicate with each other in Unity.

(3 Marks)