



**DUBLIN INSTITUTE OF TECHNOLOGY**

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**DT228/4 BSc. (Honours) Degree in Computer Science**

**DT282/4 BSc. (Honours) Degree in Computer Science  
(International)**

**DT508/3 BA (Hons) Game Design**

**DT8900/1 International Pre-Masters for  
MSc in Computing**

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**WINTER EXAMINATIONS 2017/2018**

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**GAMES ENGINES 1 [CMPU4030]**

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MR. ALAN FAHEY – DT211C

MR. PATRICK CLARKE – DT228/DT282

MONDAY 15<sup>TH</sup> JANUARY

9.30 A.M. – 11.30 A.M.

TWO HOURS

ANSWER QUESTION 1 AND ONE MORE QUESTION.

QUESTION 1 IS MANDATORY.

ALL QUESTIONS CARRY 50 MARKS.

**1. Game Engines**

- (a) Explain the main advantages of a component-based approach to game development.  
(5 marks)
- (b) Gimbal lock is a common problem when using Euler angles.
- (i) Explain what gimbal lock is. Illustrate your answer with a drawing.  
(10 marks)
- (ii) Briefly describe the observed effect of gimbal lock on a running game?  
(5 marks)
- (iii) Euler angles are often used for camera positions as well. Explain a technique for limiting the likelihood of a camera ending up in gimbal lock.  
(10 marks)
- (c) Ragdoll physics was used in Unreal Tournament 2003 and Unreal Championship, both powered by the Unreal Engine 2. Outline what ragdoll physics is and briefly examine four methods of implementing it.  
(10 marks)
- (d) Explain the difference between rigid bodies and soft bodies in game engines, by also explaining the different ways of how soft bodies can be implemented.  
(10 marks)

## 2. Physics Engines

- (a) Name four popular physics engines currently used in games programming.

(4 marks)

- (b) Physics engines were only used for game programming since the late 1990s. Explain the history of what was used before (2D and 3D) and why physics engines are beneficial for game programming.

(13 marks)

- (c) Your character starts at position (5,0,0) for x, y and z coordinates. The character travels at 10 m/s in the positive x direction. What is the location of the character after 3.5 seconds? Show how you arrived at your result.

(10 marks)

- (d) If a car starts from rest and accelerates at  $2 \text{ m/s}^2$ , then what is the car's velocity at time  $s=0$ ,  $s=1$ ,  $s=2$ ,  $s=3$ . Explain your result.

(10 marks)

- (e) You are implementing a class called GravityController. In your constructor you initialised a vec3 as follows:  
`gravity = glm::vec3(0.0f, -9.8f, 0.0f);`

Write a `GravityController::Update()` method that applies gravity to the object's transform. You will have to modify the velocity and position fields. Provide your answer in C++ or pseudo code.

(13 marks)

### 3. Quaternions

- (a) Why do we need quaternions in game programming?  
(10 marks)
- (b) What rotation does the following quaternion represent?  
[0.7 0 0 0.7]  
Your answer does not require the exact rotation degrees.  
(10 marks)
- (c) How do you check in C++ or pseudo code if two quaternions are similar?  
(10 marks)
- (d) What is the difference between LERP and SLERP?  
Illustrate your answer with a diagram.  
(10 marks)
- (e) Provide a method in C++ or pseudo code to implement a yaw rotation. Use a quaternion. Your method takes the angle of rotation as a parameter of data type float. You can use `glm::angleAxis` for defining your quaternion.  
(10 marks)