LIMERICK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA LUIMNIGH

WINTER EXAMINATIONS 2017

Year 4
Wednesday13th December 2017, 2 PM – 4 PM

LC_KGDM_KTH

Course:	**Bachelor of Science (Honours) in Computing (Games Design and Development)**
Year:	Year 4
Subject:	GAME PHYSICS COMP 08030
Time Allowed:	2 Hours
Instructions:	1. Attempt any **FOUR (4)** Questions. 2. All question carry equal marks. 3. Start each question on a new page. 4. Write the question number at the top of each page. 5. Circle the numbers of the questions you answer at the front of your answer book.

Additional Attachments or Exam Material to accompany this paper: None

Internal Examiners:
Eugene Kenny

External Examiners:
Derek O Reilly

Question 1 **(Total 25 Marks)**

a) In a soccer game, the player is attempting a penalty kick at a distance of 11 meters from the goal. The ball reaches the goal in a straight line after 1 second. What was the average acceleration of the ball? **(10 marks)**

b) Suppose a NPC police officer sets up a speed trap on a straight section of a road. He times a player who covered 300 meters in 15 seconds. If the speed limit on that section is 90 *km*/*h*, will the player get a speeding ticket? **(15 marks)**

Suppose another player is driving a car and suddenly has to break. He is going at 50 *km*/*h* and the car can decelerate at a rate of -4.55 *m*/*s*. How much time does the player need to stop?

Question 2 **(Total 25 Marks)**

a) Why is it necessary to use numerical methods to solve certain physics equation? Name, describe and compare two techniques that are used to solve certain equations numerically. **(10 marks)**

b) For a time dependent variable, x(t), satisfying the equation: **(15 marks)**

$$x(t) = 100t - 2t^2$$

and with x = 0 at t = 0 show how you would solve for x using the techniques you have described above.

Question 3 **(Total 25 Marks)**

a) *Spatial partitioning* data structures are commonly used to make the fast selection of models to test in a collision detection system. Outline in detail two such data structures. **(10 marks)**

b) State the *Separating Axis Theorem* (SAT). Illustrate how it works for two polygon shapes such as a triangular object and a rectangular object. If one of the objects was curved would SAT be of any use? **(15 marks)**

Question 4 **(Total 25 Marks)**

a) Discuss the problem of how best to represent rigid bodies for the purpose of collision detection and describe the different approaches that may be taken to solve it. **(10 marks)**

b) When your game program detects penetration of one rigid body object by another what technique would you use to work out the time of the actual collision? **(10 marks)**

c) One unwelcome effect in modelling bodies that may collide is tunnelling. What does this refer to, why does it happen and how can it be avoided? **(5 marks)**

Question 5 **(Total 25 Marks)**

a) Describe a physics model that is sometimes used to represent cloth and other soft bodies. **(10 marks)**

b) What in your opinion are the advantages and disadvantages of writing your own physics engine as compared to using a commercial one? **(15 marks)**

Useful Formulas

Equations of linear motion:	$v(t+\Delta t) = v(t) + a\Delta t$ $\bar{v} = (v(t+\Delta t) + v(t))/2$ $\Delta p_0 = \frac{1}{2}(v(t+\Delta t) + v(t))\Delta t$ $\Delta p_0 = v(t)\Delta t + \frac{1}{2}a\Delta t^2$ $v(t+\Delta t)^2 = v(t)^2 + 2a\Delta p_0$
Newton's Second Law:	$F_{net} = m \cdot a$
Static and kinetic friction	$F_s = \mu_s \cdot F_N$ and $F_k = \mu_k \cdot F_N$
Equations of angular motion:	$\omega(t+\Delta t) = \omega(t) + \alpha\Delta t$ $\bar{\omega} = (\omega(t+\Delta t) + \omega(t))/2$ $\Delta\theta = \frac{1}{2}(\omega(t+\Delta t) + \omega(t))\Delta t$ $\Delta\theta = \omega(t)\Delta t + \frac{1}{2}\alpha\Delta t^2$ $\omega(t+\Delta t)^2 = \omega(t)^2 + 2\alpha\Delta\theta$
Coefficient of restitution:	$C_R = -\frac{v_{A+} - v_{B+} \cdot n}{v_{A-} - v_{B-} \cdot n}$
Collision impulse (without rotation):	$j = -(1 + C_r)(v_{A-} - v_{B-}) \cdot n / (\frac{1}{m_A} + \frac{1}{m_B})$
Linear velocity resolution:	$v_+ = v_- + \frac{j}{m} n$
Angular velocity resolution:	$\omega_+ = \omega_- + I^{-1}(r \cdot (j \cdot n))$