

UNIVERSITY OF BOLTON

CREATIVE TECHNOLOGIES

BSC (HONS) GAMES PROGRAMMING

SEMESTER ONE EXAMINATION 2018/2019

GAMES MATHEMATICS

MODULE NO: GAP4000

Date: Thursday 17th January 2019

Time: 10:00 - 12:00

INSTRUCTIONS TO CANDIDATES:

There are **EIGHT** questions on this examination paper.

Section A – Answer **ALL FIVE** questions.

Section B – Answer **TWO** questions.

Calculators may be used for this examination.

There is a formula sheet at the back of the examination paper.

The total marks are **70**.

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Section A (30 Marks) - Please answer **ALL** questions in Section A

A1. If matrix $A = \begin{bmatrix} 1.5 & 0 \\ 0 & 1.5 \end{bmatrix}$ and matrix $B = \begin{bmatrix} 0 & 4 & 2 \\ 0 & 0 & 3 \end{bmatrix}$

i) Evaluate, where possible: **[10 marks]**

- a) $A - B$
- b) A^{-1}
- c) AB
- d) BA

ii) If matrix B represented the coordinates of a triangle, what *transformation* would matrix A 'produce' on the coordinates in matrix B? **[2 marks]**

A2. Within a computer game, a sprite is repositioned every 20ms. Each time, the sprite is moved 8 pixels to the left and 5 pixels up. If the sprite is initially at coordinate: (3, -1), find the equation of the straight line, in the form $y = mx + c$, along which the sprite appears to move. **[5 marks]**

A3. Calculate the values for x, where quadratic equation: $6x^2 + 2x - 4 = 0$,

using the quadratic formula, $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$. **[4 marks]**

A4. Within a computer game, the centre of a Player object's x and y position is at: (-2.1, 1.1) and the centre of an Enemy object's x and y position is at: (1.5, -3.8). What is the distance between the object centres, to 2 decimal places of accuracy? **[3 marks]**

A5. A function representing the position of an object within a computer game, is given by: $f(x) = x^2 + 6$. Calculate the following:

- a) $f(3)$ **[1 mark]**
- b) $f(-2)$ **[1 mark]**
- c) $f(x + 4)$ **[2 marks]**
- d) $f'(x)$ **[2 marks]**

END OF SECTION A

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Section B (40 marks) - Answer **TWO** questions from Section B

Each question is worth 20 marks

- B1 a) Convert the following binary numbers to hexadecimal:
i) 1000 1111 0101 1101 ii) 0100 1010 0111 1011 **[2 marks]**
- b) Convert the following decimal numbers to hexadecimal:
i) 129 ii) 213 **[2 marks]**
- c) Convert the following hexadecimal numbers to decimal:
i) 3C2 ii) F03 **[2 marks]**
- d) Determine the 2s complement of the binary number:
i) 1001 **[2 marks]**
ii) Use the answer in i) to, in binary numbers, calculate the
subtraction: $1110_2 - 1001_2$ **[3 marks]**
- e) Input options for a menu system, in a computer game, are to be stored in a variable named `inputOptions`, which is of 8 bit size. The following input options are stored as hexadecimal constants:
- Mouse = 0x01
Keyboard = 0x02

Assuming variable `inputOptions` is initially set to 0.

- i) Using pseudo code, or equivalent, show how to use an appropriate operator to set the Mouse input option on. **[2 marks]**
- ii) Using pseudo code, or equivalent, use an appropriate operator(s) to set the Keyboard and Mouse input options on. **[3 marks]**
- iii) Using pseudo code, or equivalent, use an appropriate selection statement, and operator, to check that the Mouse option is on. **[4 marks]**

Section B continues over the page....

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Section B continued....

B2 a) Differentiate the following, with respect to x:

- i) $y = -3x^5$
- ii) $y = -4x^2 - 4x + 6$
- iii) $y = 2x^{-6} + (x + 3)^2$
- iv) $y = 7\sqrt{x^7}$
- v) $y = \frac{1}{5x^4} - 5\sin(x)$

[12 marks]

b) The velocity of a Non-Player Character, (NPC), in a game is given by:
 $v = 10t^2 - 8t + 8$. Where v is the velocity in pixels / s and t is the time in seconds.

- i) What is the initial velocity of the NPC and the NPC's velocity after 2 seconds? **[2 marks]**
- ii) Differentiate to find the acceleration of the NPC, and state what units the acceleration would be in. **[3 marks]**
- iii) At what point in time would the acceleration change from a negative acceleration to a positive acceleration? Show how you calculated the precise time where the change in acceleration direction occurs. **[3 marks]**

B3 a) Integrate the following:

- i) $\int 3x^2 dx$
- ii) $\int_1^4 2x^4 - 9 dx$
- iii) $\int 9t^5 - 6t^3 dt$
- iv) $\int_{0.5}^1 8t^5 + 4t^{-2} dt$

[14 marks]

b) The velocity of a Non-Player Character, (NPC), in a game is given by:
 $v = 4t^3 - 8t + 6$. Where v is the velocity in Kilometres / hour and t is the time in hours.

- i) Integrate the velocity equation to obtain an expression for distance, s, and state what units the distance would be in? **[3 marks]**
- ii) Using i), or otherwise, calculate how far the NPC travelled between 0.5 and 3 seconds? **[3 marks]**

END OF QUESTIONS

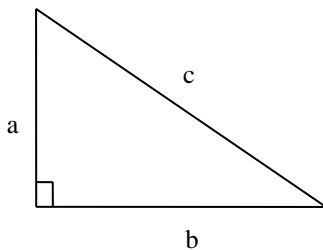
Formula sheet over the page....

Formula Sheet

Inverse Matrix formula

The inverse of the matrix $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$, is given by the formula $A^{-1} = \frac{1}{ad - bc} \begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$

Pythagoras' Theorem



For a right-angled triangle, the hypotenuse, $c^2 = a^2 + b^2$

Trigonometric ratios

$$\text{Sine (sin)} = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\text{Cosine (cos)} = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\text{Tangent (tan)} = \frac{\text{opposite}}{\text{adjacent}}$$

Standard Differentials

$y = f(x)$	$\frac{dy}{dx}$
$y = ax^n$	anx^{n-1}
$y = \text{asin}(x)$ (assuming x is in radians)	$\text{acos}(x)$
$y = \text{acos}(x)$ (assuming x is in radians)	$-\text{asin}(x)$

Standard Integrals

$y = f(x)$	$\int f(x)dx$
$y = ax^n$	$\frac{ax^{n+1}}{n+1} + c$
$y = \text{asin}(x)$ (assuming x is in radians)	$-\text{acos}(x) + c$
$y = \text{acos}(x)$ (assuming x is in radians)	$\text{asin}(x) + c$

END OF PAPER