| PAPER CODE NO. | EXAMINER : **Dr BM Diaz** |
| COMP307 | DEPARTMENT : Computer Science   Tel. No. 43696 |

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of LIVERPOOL

JANUARY 2003 EXAMINATIONS

Bachelor of Arts : Year
Bachelor of Engineering : Year 3
Bachelor of Science : Year 2
Bachelor of Science : Year 3
Bachelor of Science : Year 4

IMAGE PROCESSING, COMPUTER VISION AND GRAPHICS

TIME ALLOWED : Two Hours and a Half

INSTRUCTIONS TO CANDIDATES

SECTION A:	Answer **ALL** questions
	(Section A is worth 50%)
SECTION B:	Answer any **2** out of **4** questions
	(25 marks for each answer; Section B is worth 50%)

If you attempt to answer more than the required number of questions (in any section), the marks awarded for the excess questions will be discarded (starting with your lowest mark).

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Section A

Answer ALL questions in Section A. Section A is worth 50% of the marks available.

A1   Describe the transformation that takes the unit square centred on $x = 0.5$, $y = 0.5$ with sides parallel to the axes and rotates it by 45 degrees.

(3 marks)

A2   In the human visual system where is the *fovea centralis*? What are the main type of cells found in the foveal region?

(3 marks)

A3   Sketch the response of the *centre surround* mechanism that is said to operate at the retinal level in the human eye to a centrally located horizontal dark/light edge.

(3 marks)

A4   Describe with a simple bitmap mask example the effect of the *bitblt AND* and *bitblt XOR* operations.

(3 marks)

A5   The HSV hexcone representation of a colour is given as (1.5, 0.7, 0.5). Describe briefly what this means.

(3 marks)

A6   In computer graphics what is a *stroke device*? What are the common problems associated with stroke devices?

(3 marks)

A7   In computer graphics describe a situation where an application program might seek to use simultaneously more than one *input mode*.

(3 marks)

A8   Using a single point centre of projection 26 cm from the projection plane show how the general homogeneous point [X Y Z W] in the projection plane may be derived from the scene point [x y z 1].

(3 marks)

A9   In image processing what is meant by a spatially dependent operation?

(3 marks)

A10
Explain *back face culling* in computer graphics.

(3 marks)

A11

a) What image convolution might be used to remove salt and pepper errors from a gray-scale image? In your answer ensure you describe the main steps in the image convolution process.

(6 marks)

b) What would be the result of using a high pass filter on the salt and pepper image?

(4 marks)

A12

8	1	2
7	0	3
6	5	4

Figure 1

(a) Given the $[4^4]$ tiling and hierarchical tesseral structure based on the addressing illustrated in Figure 1, explain whether the hierarchy is *bounded* or not. Sketch and label the hierarchy to 2 levels.

(4 marks)

(b) Using the tesseral structure identified in (a) generate the corresponding addition table and calculate the answer to the following sums:

i)   52 + 2

(2 marks)

ii)   642 + 21

(2 marks)

iii)   70 - 30

(2 marks)

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Section B

Answer any 2 questions in Section B. Section B is worth 50% of the marks available.

B1

(a) In human vision what are *zero crossings* and why are they an important feature of the Marr hypothesis?

(10 marks)

(b) How does an understanding of human vision explain the computer graphics phenomenon known as *Mach banding*?

(8 marks)

(c) What technique is used in computer graphics to overcome Mach banding?

(7 marks)

B2 You are required to design a simple 3D computer graphics clock which has two hands, a round face with numbers, and a day of the week seven sided cylinder roller visible in a horizontal window in the clock face between the hands' pivot and 6 o'clock.

(a) Describe the segmentation strategy, and necessary transformations that take the clock from 10 minutes to midnight to 10 minutes after midnight and includes the rotation of the roller from Sunday to Monday.

(15 marks)

(b) Using an imperative programming language such as C or Pascal, and calls to a graphical subroutine library with which you are familiar, sketch a program that would realise the clock.

(10 marks)

B3

(a) In image processing what are the *morphology operations?*

(*10 marks*)

(b) Sketch the result of applying the following morphology operations to an image containing three touching black disks on a white background arranged in a horizontal line.

    i)   dilation,

    ii)   erosion,

    iii) opening,

    iv) closing.

(*8 marks*)

(c) You are asked to improve a binary image of text which has been scanned at low resolution resulting in a high percentage of "broken characters". Which image morphology operation might be used to correct this problem?

(*7 marks*)

B4

(a) Describe briefly the computer graphics rendering technique termed *ray casting* or *ray tracing.*

(*10 marks*)

(b) You are the graphics consultant to a company marketing ready-made kitchen units. The company wants to provide immediate 'computerised impressions' of the units their customers select. Describe the two rendering pipelines *z-buffer plus Phong shading* and that for *ray tracing* and write the advice you would give the company on which would be the most appropriate for their application.

(*15 marks*)