DUBLIN CITY UNIVERSITY

SUMMER RESIT EXAMINATIONS 2015/2016

MODULE: CA4007 – Computer Graphics and Image Processing

PROGRAMME(S):

CASE	BSc in Computer Applications (Sft.Eng.)
ECSA	Study Abroad (Engineering & Computing)
ECSAO	Study Abroad (Engineering & Computing)

YEAR OF STUDY: 4,O,X

EXAMINERS:

Dr. Ian Pitt
Dr. Alistair Sutherland (x5511)

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer two questions from Section 1 and two questions from Section 2. All questions carry equal marks.

PLEASE DO NOT TURN OVER THIS PAGE UNTIL YOU ARE INSTRUCTED TO DO SO
The use of programmable or text storing calculators is expressly forbidden.
Please note that where a candidate answers more than the required number of questions, the examiner will mark all questions attempted and then select the highest scoring ones.

Requirements for this paper (Please mark (X) as appropriate)

	Log Tables		*Thermodynamic Tables*
	Graph Paper		*Actuarial Tables*
	Dictionaries		*MCQ Only – Do not publish*
	Statistical Tables		*Attached Answer Sheet*
	Bible		*Exam Paper to be returned with Booklet*

SECTION 1 IMAGE PROCESSING

QUESTION 1 ***[TOTAL MARKS: 25]***

Q 1(a) **[5 Marks]**

The code below constructs an image of a disc of radius 15

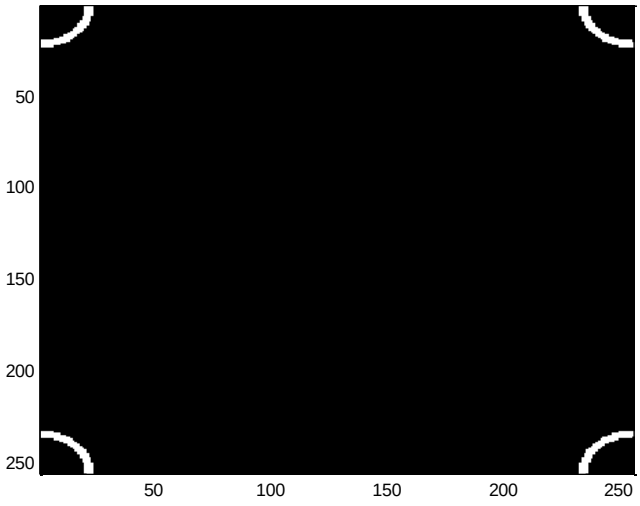
```
load dist;
disc = dist < 15;
```

Compute the Fourier Transform of the image and display the Fourier Transform (not the log of the Fourier Transform!) on your screen. Remember to scale the brightness of the FT. Sketch the FT in your exam booklet.

Q 1(b) **[5 Marks]**

The code below constructs a mask such as the one below, known as a circular band-pass filter, where `r1` is the inner radius and `r2` is the outer radius. The centre of the circles is the point `(1,1)`.

```
load dist;
mask = dist > r1 & dist < r2;
```



You can construct a mask consisting of multiple band-pass filters like this

```
mask = (dist > r1 & dist < r2) + (dist > r3 & dist < r4) ...;
```

Construct such a mask which will let through the Fourier Transform of the disc image from part 1(a). Write the Matlab commands in your exam booklet. Save the mask on your computer.

Which radii did you choose and why?

Q 1(c) **[5 Marks]**

Load the image `london`, which contains a satellite image of part of London with the Millennium Dome in the centre of the image.

Multiply the Fourier Transform of `london` by your multiple band-pass filter and Inverse Transform it. Save the filtered image on your computer. Write the Matlab commands in your exam booklet.

What effect has your filter had on the image – and on the Millennium Dome in particular? Explain why.

Q 1(d) **[5 Marks]**

Compute the Impulse Response corresponding to this mask. Display the real part of the Impulse Response using surf. Sketch it in your exam booklet.

Plot the first row of the real part of the Impulse Response. Sketch it in your exam booklet.

Q 1(e) **[5 Marks]**

Explain how convolving the `london` image with this Impulse Response leads to the effect in part (d).

[End of Question 1]

QUESTION 2 ***[TOTAL MARKS: 25]***

Q 2(a) **[5 Marks]**

Load the image `objects`, which consists of a number of rectangular objects lying horizontally and vertically.

Fourier Transform the image and display the Fourier Transform on your screen. You can use the default colormap. Remember to scale the brightness of the FT. Sketch the FT in your exam booklet. Explain the structure of the FT.

Q 2(b) **[5 Marks]**

Create a binary mask, in which the first *n* columns and the last *n* columns are all set to *1* (with *n=10*) and everything else is *0*. Write the Matlab commands in your exam booklet.

Multiply the FT by your mask and Inverse Transform it. Sketch the filtered image in your exam booklet. Write the Matlab commands in your exam booklet.

Q 2(c) **[5 Marks]**

Explain the structure of the filtered image.

What effect does varying *n* have on the filtered image? Explain why.

Q 2(d) **[5 Marks]**

Now modify the mask in part (b) by setting the first *m* rows and the last *m* rows to *0* (with *m=10*). Write the Matlab commands in your exam booklet.

Multiply the FT by your mask and inverse transform it. Sketch the filtered image in your exam booklet. Write the Matlab commands in your exam booklet.

Q 2(e) **[5 Marks]**

Explain the structure of the filtered image.

What effect does varying *m* have on the filtered image? Explain why.

[End of Question 2]

QUESTION 3 ***[TOTAL MARKS: 25]***

Q 3(a) **[10 Marks]**

Using Matlab load the file `checkerboard`

The image contains an 8x8 checkerboard in the top left corner.

Compute the Fourier Transform of this image and display it (not the log of the FT!) on the screen. It is probably better to use the default colormap. Remember to scale the brightness of the Fourier Transform. Sketch it in your exam booklet.

Q 3(b) **[15 Marks]**

Using the Convolution Theorem explain the following three features of the Fourier Transform

(i) The FT contains replication. Which component of the FT is being replicated? Which aspect of the image gives rise to this component?

(ii) Which aspect of the image causes the replication? What determines the spacing of the replications?

(iii) Why are some of the replications less bright than others or even missing altogether?

[End of Question 3]

SECTION 2 COMPUTER GRAPHICS

QUESTION 4 ***[TOTAL MARKS: 25]***

Q 4(a) **[14 Marks]**

Edit the example program `simple.c` so that the square rotates about its centre. Save the program as `Rotate.c`

Q 4(b) **[11 Marks]**

Edit the previous programme so that the square will rotate clockwise when the mouse is on the left-hand side of the image and rotate anti-clockwise when the mouse is on the right-hand side.

Save the program as `Rotate.c`

[End of Question 4]

QUESTION 5 ***[TOTAL MARKS: 25]***

Q 5(a) **[14 Marks]**

Edit the example program `simple.c` and write a program which allows you to simulate a brushstroke, i.e. when you move the mouse with the left button held down, you should get a tapering stroke, which decreases in width and brightness as you move. Save the program as `Brush.c`

Q 5(b) **[11 Marks]**

Add a menu to the previous program. The menu should be attached to the right mouse button. The menu should have six entries. The first three should allow you to select the initial width of the brushstroke and the second should allow you to select the colour.

Save the program as `Brush.c`

[End of Question 5]

QUESTION 6 ***[TOTAL MARKS: 25]***

Q 6(a) **[11 Marks]**

Edit the example program `cube.c` and create a cylinder of radius 0.5 and height 1.0 with the centre of its bottom face at the origin and its axis along the y-axis. Save the program as `Cylinder.c`

Q 6(b) **[14 Marks]**

Now add a cuboid of length 1.0 and side 0.1 with the centre of its bottom face at the same position as the centre of the top face of the cylinder and its axis pointing in the positive x direction.

Save the program as `Cylinder.c`

[End of Question 6]

[END OF EXAM]