DUBLIN CITY UNIVERSITY

SEMESTER 2 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	Dictionaries		*MCQ Only – Do not publish*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]**

Load the images `smalldisc` and `disc`, which contain images of discs. The disc in `disc` has twice the radius of the disc in `smalldisc`.

Fourier Transform the images and display the Fourier Transforms (FTs) on your screen. Remember to scale them. Sketch the FTs in your exam booklet. Explain the differences between the two FTs.

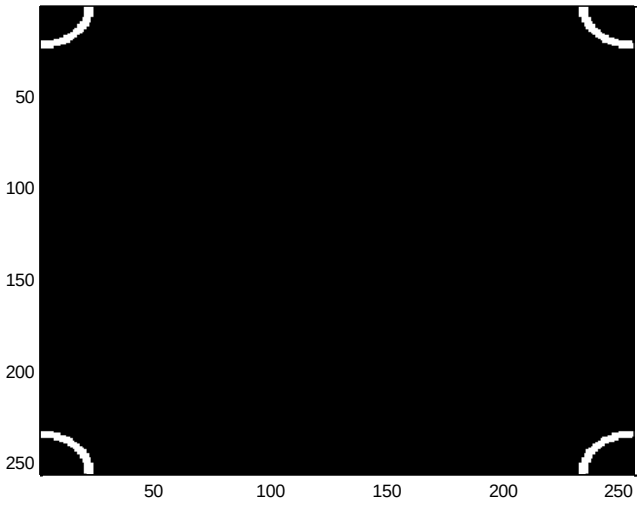
Q 1(b) **[5 Marks]**

Now create an image `x` which is the sum of `disc` and `smalldisc`. Compute the FT of `x`.

```
x = disc + smalldisc
```

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;
```



Construct a band-pass filter which lets through a part of the FT of `x` which contains mainly data due to `smalldisc`. Which radii did you choose and why?

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

Multiply the FT of `x` by the band-pass filter and Inverse Transform it. Sketch the filtered image in your exam booklet. Write the Matlab commands in your exam booklet.

Explain the structure of the filtered image.

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

Construct a band-pass filter which lets through a part of the FT of `x` which contains mainly data due to `disc`. Which radii did you choose and why?

Multiply the FT of `x` by the band-pass filter and Inverse Transform it. Sketch the filtered image in your exam booklet. Write the Matlab commands in your exam booklet.

Explain the structure of the filtered image.

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

What effect does the binary nature of the mask have on the filtered images? Describe how you would reduce this effect.

[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 which will let through horizontal objects but impede vertical ones. Sketch the mask in your exam booklet. Explain the structure of your mask. Write the Matlab commands in your exam booklet.

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

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.

Explain the structure of the filtered image.

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

Compute the Impulse Response function corresponding to the mask. Describe the structure of the Impulse Response. Sketch it in your exam booklet.

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

Explain using diagrams how convolving the `objects` image with this Impulse Response reduces vertical objects more than horizontal ones.

What effect does the Impulse Response have on the ends of the horizontal objects? Explain why.

[End of Question 2]

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

Q 3(a) **[5 Marks]**

Using Matlab load the file `abdiag`

The image contains the letters A and B superimposed on each other. Both letters have been sampled diagonally but the sample direction of A is perpendicular to that of B.

Compute the Fourier Transform of this image and display it 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) **[5 Marks]**

Using the Convolution Theorem explain the structure of the Fourier Transform.

Q 3(c) **[5 Marks]**

In Matlab construct a mask that will let through only the letter B. Sketch the mask in your exam booklet.

Multiply the Fourier Transform by your mask. Carry out an Inverse Transform and sketch the filtered image in your exam booklet. Write the commands in your exam booklet.

Q 3(d) **[5 Marks]**

Compute the Impulse Response Function corresponding to this mask. Sketch it in your exam booklet. You should display the real and imaginary parts separately. You can use the Matlab function `bar3`.

Q 3(e) **[5 Marks]**

Explain using pictures, if necessary, how convolving the image in part (a) with the Impulse Response Function in part (d) leads to the image in part (c).

[End of Question 3]

SECTION 2 COMPUTER GRAPHICS

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

Q 4(a) **[13 Marks]**

Edit the example program `simple.c` and write a reshape function which maintains the square at the same size when the window is resized. Save the program as `Reshape.c`

Q 4(b) **[12 Marks]**

Edit the previous programme so that the colour of the square will change to green whenever the mouse enters inside it and change back to red when it leaves it.

Save the program as `Reshape.c`

[End of Question 4]

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

Q 5(a) **[13 Marks]**

Edit the example program `simple.c` and write a program which allows you to create red rectangles on a blue background. The first time you click the left mouse button you can select the top-left corner of the rectangle. The second time you click with the left-mouse button you select the bottom-right corner of the rectangle and the rectangle appears on the screen. Save the program as `Mouse.c`

Q 5(b) **[12 Marks]**

Add a menu to the previous program. The menu should be attached to the right mouse button. The menu should have two entries. The first should clear the screen and the second should exit the program.

Save the program as `Mouse.c`

[End of Question 5]

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

Q 6(a) **[13 Marks]**

Edit the example program `cube.c` and give the faces of the cube the material properties of red plastic. Save the program as `RedCube.c`

Q 6(b) **[12 Marks]**

Now add a point light source to the scene at a distance of 1.0 from the centre of the cube. Make the point source rotate in a circle around the centre.

Save the program as `RedCube.c`

[End of Question 6]

[END OF EXAM]