DUBLIN CITY UNIVERSITY

SEMESTER 1 EXAMINATIONS 2014/2015

MODULE:	CA431 – Digital Image Processing	
PROGRAMME(S):		
CASE	BSc in Computer Applications (Sft.Eng.)	
ECSA	Study Abroad (Engineering & Computing)	
YEAR OF STUDY:	4,X	
EXAMINERS:	Dr Alistair Sutherland	(Ext:5511)
	Dr Ian Pitt	
TIME ALLOWED:	2 Hours	
INSTRUCTIONS:	Answer 3 questions. 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☐	*Dictionaries*	☐	*MCQ Only – Do not publish*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*

QUESTION 1 ***[TOTAL MARKS: 33]***

Q 1(a) **[6 Marks]**

Using Matlab load the following file

```
load 'p:\\public\\alistair\\building'
```

which contains a 2D image of a building.

Fourier Transform this image and display the logarithm of the Fourier Transform on your screen using the grayscale colormap. Write the commands in your exam booklet.

Sketch the Fourier Transform in your exam booklet.

Q 1(b) **[27 Marks]**

For each of the three areas of the image listed below, create a mask in Matlab which selects the parts of the Fourier Transform which correspond to that area. Sketch the mask in your exam booklet showing its relation to the structure of the Fourier Transform. Multiply the Fourier Transform by your mask and carry out an Inverse Transform. Sketch the resulting image indicating any changes due to the filtering.

(i) The white capping on the gables at the end of the sloping roof
(ii) The slates on the roof
(iii) The brightly-lit wall at the right-hand side of the image

Each of the above three parts is worth 9 marks.

[End of Question 1]

QUESTION 2 ***[TOTAL MARKS: 33]***

Q 2(a) **[8 Marks]**
Using Matlab load the following files

```
load 'p:\\public\\alistair\\annulus'
```

which contains an image of a ring with thickness 20 pixels

```
load 'p:\\public\\alistair\\disc'
```

which contains an image of a disc with diameter 20 pixels.

How can you express the ring as a convolution of the disc with another shape? What is the other shape?

Q 2(b) **[8 Marks]**
Explain using the Convolution Theorem, how you can deconvolve the ring to obtain the other shape. Using Matlab, deconvolve the ring. Write the Matlab commands in your exam booklet.

Sketch the deconvolved image.

Q 2(c) **[8 Marks]**
Explain how you would adapt the technique you described in part (b) to allow for the effects of noise in the convolved image.

Q 2(d) **[9 Marks]**
Now load the following file

```
load 'p:\\public\\alistair\\annulusnoise'
```

which is the annulus file with added random white noise.

Using the technique you described in part (c) deconvolve the image. Write the Matlab commands you used to do this in your exam booklet.

Describe the restored image now. How does it differ from the restored image in part (b)? Explain why these effects happen.

[End of Question 2]

QUESTION 3 ***[TOTAL MARKS: 33]***

Q 3(a) **[3 Marks]**
Create a 256x256 binary high-pass mask with boxes of 30x30 in each corner. Write the Matlab commands in your exam booklet.

Q 3(b) **[7 Marks]**
Using Matlab, compute the Fourier Transform of the mask.

Sketch the Fourier Transform of the mask in your exam booklet. Plot a cross-section of the Fourier Transform through the first row. Sketch the cross-section in your exam booklet.

Q 3(c) **[8 Marks]**
Explain using diagrams, how convolving an image with this Fourier Transform causes edge-enhancement.

Q 3(d) **[5 Marks]**
What aspect of the Fourier Transform of the mask is caused by the binary nature of the mask? What effect would this have on an edge-enhanced image?

Q 3(e) **[5 Marks]**
Now create a Gaussian version of the binary high-pass mask. Write the Matlab commands in your notebook.

Q 3(f) **[5 Marks]**
Fourier Transform this Gaussian mask and plot a cross-section through the first row of the Fourier Transform. Sketch the cross-section in your exam booklet. How does it differ from the cross-section in part (b)?

[End of Question 3]

QUESTION 4 ***[TOTAL MARKS: 33]***

Q 4(a) **[3 Marks]**
Using Matlab load the lenna file

```
load 'p:\\public\\alistair\\lenna'
```

The lenna image is of size 256x256.

You could regard the 256x256 image as a sampled version of a 512x512 image, in which every second row and every second column has been set to zero. Create this 512x512 image using Matlab by embedding the 256x256 image in a 512x512 array of zeros. Write the Matlab commands in your exam booklet.

Q 4(b) **[5 Marks]**
Compute the Fourier Transform of this sampled 512x512 image and display it on the screen. Remember to scale the Fourier Transform. Sketch it in your exam booklet.

Q 4(c) **[5 Marks]**
Using the Convolution Theorem, explain the structure of the Fourier Transform.

Q 4(d) **[8 Marks]**
What mask would you use to generate the Fourier Transform of the unsampled 512x512 image from the Fourier Transform in part (b)? Sketch the mask in your exam booklet.

Using Matlab, multiply the Fourier Transform in part (b) by your mask. Carry out an Inverse Transform. Write the Matlab commands in your exam booklet.

How does the generated image compare to the 256x256 version of lenna?

Q 4(e) **[5 Marks]**
Compute the Impulse Response Function corresponding to this mask. Sketch it in your exam booklet.

Q 4(f) **[7 Marks]**
Explain using diagrams, how convolving the sampled 512x512 image in part (a) with the Impulse Response Function in part (e) leads to the unsampled 512x512 image in part (d).

[End of Question 4]