DUBLIN CITY UNIVERSITY

SEMESTER ONE EXAMINATIONS 2008

MODULE: ***(Title & Code)***	Image and Video Compression EE554
COURSE:	Grad. Cert. in Electronic Systems (GCES) Grad. Dip. in Electronic (GDE) Masters in Electronic (MEN) Grad. Cert. in Telecommunications (GCTC) Grad. Dip. in Telecommunications Engineering (GTC) Masters in Telecommunications Engineering (MTC) Remote Access to Continuing Eng. Education (RAE)
YEAR:	C
EXAMINERS:	Prof. Noel E O'Connor, ext. 5078 Dr. David Sadlier, ext. 6830 Prof. Paul Rees
TIME ALLOWED:	3 Hours
INSTRUCTIONS:	Please answer 4 questions. All questions carry equal marks

Requirements for this paper ***Please tick (X) as appropriate***		
		Log Table
	X	***Graph Paper***
		Attached Answer Sheet
		Statistical Tables
		Floppy Disk
		Actuarial Tables

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.

PLEASE DO NOT TURN OVER THIS PAGE UNTIL YOU ARE INSTRUCTED TO DO SO

Question 1

1(a) A video sequence usually contains significant **SPATIAL**, **TEMPORAL** and **PERCEPTUAL** redundancy. Explain what is meant by each of these types of redundancy and explain how it is typically exploited in a video compression scheme. **[6 Marks]**

1(b) Define what is meant by a **BINARY SYMMETRIC SOURCE** in information theory. By filling in the table below, calculate the entropy of a Binary Symmetric Source when the probability of one symbol ranges from 0 to 1 in increments of 0.1. Use the table to **PLOT THE ENTROPY** of the source as a function of symbol probability. Outline **THREE PROPERTIES** of entropy that can be generalised from your plot. **[7 Marks]**

p	$H(x)$
0.0	
0.1	
0.2	
...	
1.0	

where p is the probability of one symbol and $H(x)$ is the corresponding entropy of the source.

1(c) Briefly outline how individual pixels are encoded in the **LOSSLESS** mode of the ISO JPEG image compression standard. Use text, diagrams and sample pixel values to illustrate your answer. **[8 Marks]**

> **Note:** Your example should be for illustrative purposes only. You do not need to provide a real variable length codeword for your illustrative example, nor justify the efficiency or otherwise of the approach.

1(d) *"Recent video compression standards support both arithmetic and Huffman coding."* Is this statement **TRUE** or **FALSE**? Justify your answer by explaining why the international standards community have taken this approach. **[4 Marks]**

[Total marks: 25]

Question 2

2(a) Briefly describe how the following transformations or properties affect the coefficients of the Fourier Series representation of a periodic function with period **L**: **[13 Marks]**

1. Spatial shift of waveform
2. Amplitude shift of waveform
3. Waveform even/odd symmetry
4. Waveform translational symmetry
5. Waveform discontinuities or discontinuities of its derivatives

Outline how these properties can be used to develop the **DISCRETE COSINE TRANSFORM** (DCT) and the **DISCRETE SINE TRANSFORM** (DST) of a 1-D block of data samples taken from a non-periodic sampled signal. Explain why discrete cosine transforms are in general preferred to discrete sine transforms.

2(b) Distinguish between the design of a scalar quantization process using the **Lloyd-Max** (Mean Square Error minimization) approach, the **COMPANDING** approach and the **OPTIMUM UNIFORM QUANTIZER** approach. **[12 Marks]**

[Total marks: 25]

Question 3

3(a) Give an overview of the main features of the ISO JPEG Standard **LOSSY** encoding scheme, explaining how the various component processes are justified. **[7 Marks]**

3(b) Outline the structure of the video compression layer of the ISO **MPEG-1** digital audio/video coding standard, explaining the role played by each component process. **[9 Marks]**

3(c) You are required to develop a **VIDEO RETRIEVAL SYSTEM** that exclusively uses information contained in a compressed MPEG-1 video layer bitstream. The retrieval system is to be based on segmenting video into shots and characterising: **[9 Marks]**

1. the dominant colour in each shot and;
2. the dominant camera motion in each shot.

Describe how you would use the information in the layered data structure used in the MPEG-1 standard to determine the information required for the application.

[Total marks: 25]

Question 4

4(a) Sketch the high level structure of a **H.261 VIDEO ENCODER** and briefly describe its operation. Explain why **DECODING** is necessary in the encoder and indicate the decoding processes in your diagram. **[9 Marks]**

4(b) Describe the **EIGHT DIFFERENT CODING MODES** possible for an individual macroblock in a H.261 video encoder. **[7 Marks]**

4(c) Why is a **MACROBLOCK ADDRESSING** mechanism necessary within the H.261 video bitstream syntax? Describe how this mechanism is **IMPLEMENTED** in practice. **[4 Marks]**

4(d) What is meant by the term **NORMATIVE** in the context of an image/video compression standard? Describe one normative and one non-normative aspect of the H.261 standard. **[5 Marks]**

[Total marks: 25]

Question 5

5(a) Using diagrams and text, **COMPARE** and **CONTRAST** any two different motion estimation strategies that could be used in a video encoder. Use **DIAGRAMS** of positions searched to illustrate your answer. **[8 Marks]**

5(b) List and very briefly describe one **ADVANTAGE** and one **DISADVANTAGE** of hierarchical motion estimation. **[4 Marks]**

5(c) Describe the **MAJOR** difference between MPEG-4 and other video compression standards that allows MPEG-4 to facilitate enhanced forms of user interaction. Explain **TWO** new forms of **INTERACTION** that are made possible as a result. **[5 Marks]**

5(d) Explain the method of **BINARY SHAPE CODING** employed in the MPEG-4 video compression standard to encode individual binary alpha blocks. Use appropriate diagrams in order to illustrate your explanation. **[8 Marks]**

[Total marks: 25]