Data Provided: None

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2008-2009 (2 hours)

Multimedia Systems 1

Answer **THREE** questions. **No marks will be awarded for solutions to a fourth question.** Solutions will be considered in the order that they are presented in the answer book. Trial answers will be ignored if they are clearly crossed out. **The numbers given after each section of a question indicate the relative weighting of that section.**

1. An image with resolution 100 x 100 consists of six different gray levels (0 through 5). The frequencies of occurrence of these gray levels in the image are as in the following table:

Gray Levels	0	1	2	3	4	5
Frequencies of occurrence	600	1000	1200	4000	2000	1200

Answer the following questions based on the above information showing all steps involved in your computations.

a. Compute the theoretical minimum average code length required to store the above image data. **(3)**

b. Derive the Huffman code for the above data source. **(6)**

c. Compute the efficiency of the derived Huffman code. **(3)**

d. If the data was originally coded using fixed length binary codes, calculate the compression ratio achieved by using the derived Huffman code. **(2)**

e. How long would it take to send the Huffman coded image using a data link with a channel capacity of 1 M bits per second and the propagation velocity of $3x10^8$ ms^{-1} over a distance of 150 km? **(4)**

f. State *an advantage* and *a drawback* of Huffman codes over fixed length binary codes. **(2)**

2.

2. **a.** List three advantages for representing signals in a digital format rather than in an analogue one. **(3)**

b. The digitisation of an analogue audio signal with the amplitude varying between values 2.5 V and -1.5 V using a sampling rate of 20 kHz results in a digital signal with 240 kbps data rate.

(i) What is the highest frequency of this audio signal that can be recorded using this digitisation process?

(ii) What is the quantisation step size used in the quantiser in this analogue-to-digital conversion? **(5)**

c. CD quality audio is digitised using 44.1 kHz sampling rate with 16 bits per sample quantisation. Briefly explain the effect on the audio quality if 8 bits per sample are used, instead of 16 bits per sample? **(2)**

d. Sketch a block diagram of a *Linear Predictive Coder* (LPC) model for speech production and state how it simulates the voiced and unvoiced sounds of the human speech **(5)**

e. (i) Explain, using suitable diagrams, the "*frequency masking*" process with regard to the human hearing system.

(ii) How do we make use of frequency masking in *MP3* encoders? **(5)**

3. **a.** Define, giving a simple example of each, the **three** main types of broadcast – *unicast*, *multicast* and *broadcast*. **(3)**

b. Describe *frequency-division multiplexing* and *time-division multiplexing*, together with an example of a communication system that uses each of them. **(4)**

c. Briefly describe the two main switching strategies of digital communication systems – *circuit switching* and *packet switching.*

Give an example of each. **(3)**

d. Sketch the timeline diagram for sending packets between a source and destination using **a reliable communication protocol** and explain what is meant by the term "*round trip time*" (RTT). **(3)**

e. Describe briefly the functions of the following layers of the *TCP/IP* communication protocol:

(i) Network layer

(ii) Internet Protocol layer

(iii) Transport Control Protocol layer

(iv) Application layer **(4)**

f. Explain the difference between the TCP-IP based transmission and UDP-IP based transmission.

State an application where UDP-IP is commonly used. **(3)**

4. **a.** Briefly explain why multimedia data compression is possible and why it is often necessary. **(4)**

b.

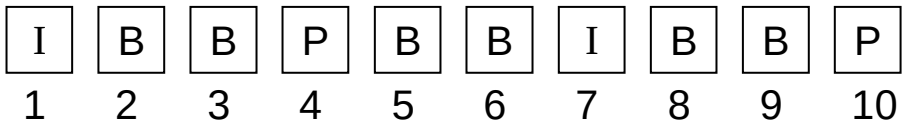

Figure 1: Frame ordering in video coding.

Figure 1 shows the frame number and the coding type of frames, arranged in display order, in a video sequence.

(i) What is the GOP (group of picture) size for this arrangement?

(ii) What is the coding/decoding order of all frames shown in Figure 1?

(iii) What is the maximum number of frames that needs be kept in the frame buffer at any given time? **(3)**

c. Explain how the 7th frame (an I-frame) of the video coding configuration shown in Figure 1 is treated in the encoder. **(3)**

d. A digital video broadcasting company has designed an image capture system that generates video for Ultra High Definition Television (Ultra-HDTV) transmissions in the UK. The initial system consists of the following specifications:

- The number of horizontal TV lines: 2160
- Aspect ratio (width : height): 16:9
- Colour format: YCbCr 4:2:0
- Colour depth: 8 bits per each colour component sample
- Frame rate: 50 frames per second (Non-interlaced)

The video is encoded using the I-P-B arrangement shown in Figure 1 before transmission. The compression ratios used for a single frame of I, P and B types are 30:1, 90:1 and 180:1, respectively.

(i) Compute the bit rate required to transmit an uncompressed Ultra-HDTV video sequence with above specifications.

(ii) What would be the overall compression ratio if this compression scheme was used?

(iii) What would be the bit rate of the compressed video? **(9)**

e. Recommend a digital video compression standard that can be used for reduction of the data rate of an Ultra-HDTV transmission system. **(1)**

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