Data Provided: None

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2009-2010 (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 audio signal with 20 kHz bandwidth is sampled at the Nyquist rate into 5 distinct voltage levels as follows: {-2, -1, 0, 1, 2}. The corresponding probabilities of occurrence for these symbols are {0.08, 0.1, 0.55, 0.12, 0.15}, respectively.

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

a. Compute the theoretical minimum average number of bits required to store the output samples of the above data source. **(3)**

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

c. Compute the efficiency of the derived Huffman code. **(4)**

d. How do you verify that the Huffman code derived in question 1.b is unambiguous? **(2)**

e. If these audio signal samples are originally represented using the *fixed length binary codes*, what compression ratio can be achieved by using the Huffman code derived in question **1.b.**? **(2)**

f. Using the Huffman code derived in question **1.b**, how many minutes of this audio signal can be recorded in a 128 Mbyte storage device? **(3)**

2. **a.** Draw a block diagram of the Internetworking architecture and describe briefly the functionality of the key layers. **(6)**

b. A tabloid of 32 pages containing 20 Mbytes of data is to be sent from the editorial office in Sheffield to the printing unit in London over a data link with a channel capacity of 120 Mbits per second and the propagation velocity of $3x10^8$ ms^{-1}. The distance between London and Sheffield is 210 km. Compute the total time taken to deliver this data using the above link. **(3)**

c. Describe briefly the two main switching strategies used in communication systems – "circuit switching" and "packet switching".

Give an example of each. **(4)**

d. Describe *frequency-division multiplexing* and *time-division multiplexing*, using suitable diagrams and giving an example of a communication system that uses it. **(5)**

e. Sketch the timeline diagram for sending packets between a source and destination using a reliable communication protocol. **(2)**

3. **a.** State why data (such as music or video) compression is possible and why is it often necessary? **(4)**

b. Sketch a block diagram of a *Linear Predictive Coder* (LPC) model for speech representation and note how it simulates the various elements of the human vocal system. **(5)**

c. CD quality audio is digitised using 44.1 kHz sampling rate with 16 bits per sample quantisation. What will be the effect on the audio quality if 11 kHz sampling rate with 8 bits per sample quantisation is used? **(3)**

d. Explain, using suitable diagrams, the processes "temporal masking" and "frequency masking" with regard to the human hearing system. **(4)**

e. Draw a block diagram of an mp3 audio coding system and explain briefly the functionality of the main components of the system. **(4)**

4. **a.** What is the difference between *lossless* compression and *lossy* compression? Give an example of each. **(4)**

b. Explain why we use the luminance and two chrominance signals form (Y Cb Cr) rather than the additive primary colour form (Red-Green-Blue) for colour television broadcasting. **(3)**

c. Grey level (luminance) images usually use colour depth of 8 bits per pixel. What would be the effect on the visual quality of an image if 3 bits per pixel are used, instead of 8 bits per pixel? **(3)**

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

- The number of horizontal TV lines :- 810

- Aspect ratio (width : height) :- 16:9

- Colour format :- YCbCr 4:2:0

- Colour depth :- 8 bits per each colour component sample

- Frame rate : 25 frames per second (non-interlaced)

How much disk space would it take to store a 1-hour HDTV programme in the uncompressed format? **(5)**

e.

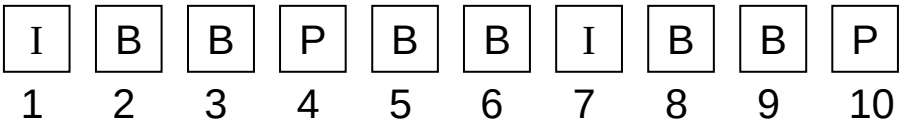

Figure 1: Frame ordering in video coding.

The video sequence in question **4.d** is encoded using the I-P-B arrangement shown in above Figure 1. The compression ratios used for I, P and B frames (including motion vector and prediction error coding) are 10:1, 40:1 and 80:1, respectively. What is the data rate of the compressed video? **(5)**

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