Data Provided: None

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Autumn Semester 2007-2008 (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. a. Explain, using suitable diagrams, the processes "temporal masking" and "frequency masking" with regard to the human hearing system. **(4)**

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

c. 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)**

d. 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 4 bits per pixel are used, instead of 8 bits per pixel? **(3)**

e. 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 :- 720
- Aspect ratio (width : height) :- 16:9
- Colour format :- YCbCr 4:2:2
- Colour depth :- 10 bits per each colour component sample
- Frame rate : 50 fields per second (Interlaced)

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

f. Recommend a digital video compression standard that can be used for further reduction of the data rate of the HDTV transmission system in question 2.e. **(1)**

2. An audio signal with a bandwidth 10 kHz is sampled using the Nyquist rate into 5 distinct voltage levels as follows: {-2, -1, 0, 1, 2}. The corresponding probabilities of occurrence for these symbols are {0.05, 0.25, 0.3, 0.25, 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 code length 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. **(3)**

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

e. Using the Huffman code derived in question 1.b, how many minutes of this audio signal can be recorded in a 64 Mbyte storage device? **(4)**

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

3. **a.** List three examples of network errors that can be experienced in data communication. **(3)**

b. Describe briefly the different types of redundancies present in a digital image and how they are eliminated in the compression process. **(5)**

c. In video coding, each frame is encoded in one of the following three modes: I-frames, P-frames and B-frames. Three scenarios of possible coding arrangements are shown below:

Scenario 1: I I I I I I I I I I ….. (I frames only)

Scenario 2: I P P P P P P P P P ….. (one I frame followed by P frames)

Scenario 3: I B B B P B B B I B (using combinations of I-P-B frames)

Compare the above three coding scenarios with regard to their

(i) coding efficiency

(ii) computational complexity and

(iii) propagation of errors in transmission. **(6)**

d. Consider the Scenario 3 of frame arrangement in above question (3.c) and answer the following questions

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

(ii) What is the coding/decoding order of all frames?

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

e. Explain how the 7^{th} frame (a B-frame) of the scenario 3 (in question 3.c) is encoded. **(3)**

4. **a.** Briefly describe the two main switching strategies of communication systems – "circuit switching" and "packet switching".

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

b. Sketch the timeline diagram for sending packets between a source and destination using **a reliable communication protocol**. **(4)**

c. List three of the main functions of the Transport Control Protocol (TCP). **(3)**

d.

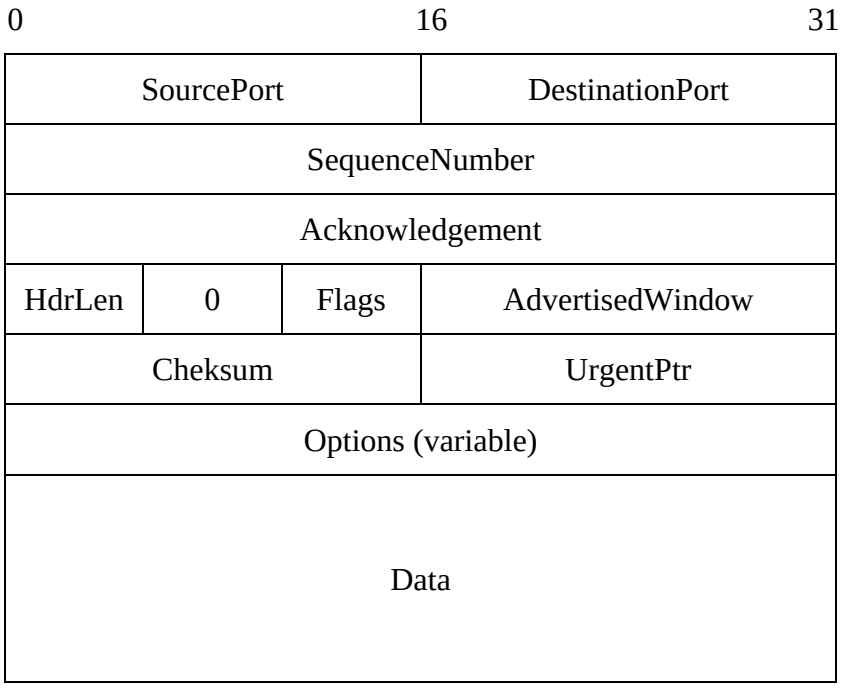

Figure 1

Figure 1 shows the header structure of a TCP datagram. State the function of the following fields:

(i) DestinationPort
(ii) SequenceNumber
(iii) AdvertisedWindow

(3)

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

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

f. Calculate the delay due to **transmit time** for a 2 K byte packet sent across a 100 km microwave link with a channel capacity of 1 Mbps. Assume that the speed of light is $3 \times 10^8 \, ms^{-1}$. **(3)**

GCKA / NMA