West Virginia University
LANE DEPARTMENT OF COMPUTER SCIENCE & ELECTRICAL ENGINEERING
CS691/CS591K: MULTIMEDIA SYSTEMS
FINAL TEST

TODAY’S DATE: NOVEMBER 29, 2001
TIME ALLOWED  2HRS

♦ Answer all questions
♦ This test is worth 100 marks
♦ The test is open book
♦ Carefully check the number of marks allocated to each question. This gives an indication of the degree of detail expected in the question, and the amount of time you are expected to spend on the question.
Q1 [25 marks]
The coded MPEG stream is usually represented as a sequence of I P B pictures. Practically, the bit stream can be defined in terms of \( n \) - the number of frames in a group of picture (GOP), and \( m \) - the number of B frames between any two anchor frames (i.e. I or P frames). We assume that given \( m, n \) is always chosen such that we always have B frames between anchor frames. E.g. for IBPBPBI, \( n=6, m=1 \); for IBPBBPBBPBBPBBI, \( n=9, m=2 \); for IBPBPBBPBBPBBPBBI, \( n=15, m=2 \).

Let \( S_I, S_P \) and \( S_B \) be the respective size (in bytes) of the I, P and B frame. We assume for simplicity that for a given picture type, \( S_I, S_P \) and \( S_B \) remain constant, and that \( S_I > S_P > S_B \). Also, let \( S_F \) be the size of the original video frames.

(a) [10 marks] Derive a relation for the compression ratio \( C_R \) in terms of the above parameters.

(b) [6 marks] How is the compression ratio affected by the number of B frames and the length of the GOP?

(c) [4 marks] Assume that based on extensive simulations, on average, the size of the different frames can be related as follows: \( S_I = \frac{1}{10} S_P = 2 S_P = 4 S_B \). What will the compression ratio be?

(d) [6 marks] Give one advantage and two disadvantages in using large values for the length of the GOPs.

Q2 [30 marks]
(a) [4 marks] Describe two situations/applications in which multicasting will be the most appropriate mode of communication for multimedia data.

(b) [2 marks] Give a similar description for one situation/application where anycast will be more appropriate.

(c) [12 marks] In general, multicasting in multimedia communications can be sender-oriented or receiver-oriented.
   (i) Briefly describe the working principles for the two types of multicast.
   (ii) What are their respective merits and demerits?
   (iii) For each type of multicast, give one example application, where it is more appropriate than the other. Justify your example.

(d) [4 marks] Briefly describe what is meant by reliable multimedia multicast. How can it be achieved?

(e) [4 marks] Describe one application or scenario where we may need reliable multicast. Describe one where we may not.

(f) [4 marks] You are given the following network of nodes in a multimedia communications environment (see attached Figure). A multicast sender at node B wishes to send data packets to receivers in its multicast group. The group members are located at nodes D, E, F, H, J, K. Using a diagram, show two possible ways the sender can send packets to all the receivers. Assume each hop is a unit cost.
Q3 [20 marks]
(a) [5 marks] Precision and recall are two measures that we can use to measure the effectiveness of a multimedia retrieval system. Briefly describe the meaning of these two measures. Why is it that the two measures are often opposing to each other?

(b) [6 marks] Describe two other methods that can be used to measure the effectiveness of a multimedia information retrieval algorithm. Indicate one advantage and one disadvantage of using each of the methods.

(c) [9 marks] In a debate on performance measures for multimedia information systems, a multimedia information system designer argues that precision is a better measure of multimedia information retrieval performance. Another argues that recall is a better measure. Your company has asked you to represent it in the debate. However, you have the task of presenting an argument on both sides of the debate.

(i) What will be your argument in favor of each proposal?
(ii) What will be your argument against each proposal?

Q4 [25 marks]
(a) [14 marks] A geek friend of yours who is so much into the "MP3/Napster culture" is intrigued by the lightening speed at which he can download MP3 audio files over the Internet. He observed that the files are typically much smaller in size when compared with the corresponding music files stored with the traditional .wav format (windows waveform format). Yet, when he plays out the MP3 files, he could not notice the difference between the two. He has read somewhere that MP3 files are compressed. Knowing that you have just completed a course in multimedia systems, he approached you for some clarifications on the following:

(i) The special features of music data make them so easily amenable to such levels of compression
(ii) The stages of processing on the music data needed to produce such reduced MP3 files
(iii) Being an ardent follower of the concept of "no free lunch", he also wishes to know the problems/ limitations/drawbacks (if any) in performing this kind of reduction.

How will you explain to your friend?

(b) [12 marks] A professional photographer was worried about how she could protect her rights over the huge collection of photos of natural scenes that she has garnered over the years. Being shots of natural environments, she was equally aware that it is easy for any one to take photos in the same (or similar) environments. She is however very confident that her skill can be matched by only very few of her peers. Thus, she was more concerned with possible digital manipulation of her pictures by pirates. Having watched a recent advert by your start-up company on your patented technique for digital watermarking, she has approached your company for advice. Since she has already seen a number of demos from competing companies on digital watermarking, she was more interested in two issues:

(i) How you can convince her of the superiority of your technique.
(j) The problems she might have in her quest for "the most superior" algorithm.

Being the technical leader for the digital copyright group in your start-up, how will you convince her? What problems will you tell her?