# UNIVERSITY COLLEGE LONDON

*University of London*

# EXAMINATION FOR INTERNAL STUDENTS

*For the following qualifications :-*

B.Sc.        M.Sci.

Comp Sci B361: Multimedia Systems

COURSE CODE          :  COMPB361

UNIT VALUE           :  0.50

DATE                 :  30-APR-01

TIME                 :  10.00

TIME ALLOWED         :  2 hours 30 minutes

01-C0352-3-90

TURN OVER

(Answer three questions out of five. College recognized calculators are permitted. In calculations make sure that you show all the working out, and that you take care to include the units for each value).

Question 1

You work for a company that wishes to become a Voice over IP provider. You have been asked to write a technical report that includes the following:-

a)  Background material on LPC and analysis-by-synthesis codecs. Include in your answer a diagram for each codec, and an explanation of the deficiencies of LPC and how these are improved upon by analysis-by synthesis codecs.                                                                                     [12 marks]

b)  Calculation of the bit-rates for the following codecs given: -
    ADPCM G.721, sampling rate = 8000 samples per second, bits per codeword = 4.
    CS-ACELP G.729 frame size =  lOms, LP coefficients = 18 bits, excitation information = 62 bits.
                                                                                                            [8 marks]

c)  Technical input for a business case for a possible VOID solution - one based on a PC. Your input should focus on delay and loss issues - which components of the system give rise to delay and loss. Assume that the PC-based solution consists of software running on a  user's general purpose PC - the PC is used as a telephone. Include in your answer a discussion of which of the ADPCM or G.729 codecs you would recommend for each scenario.                                                                               [13 marks]

Question 2

The company 'TVA' transmits television programmes using digital transmission. A team is looking at moving from the standard size television only to offer wide-screen as well, and you have been asked to provide the following technical input: -
a)  i) How do plasma display panels produce colour?                                                      [2 marks]
    ii) What factors does High Definition Television (HDTV) vary to produce greater resolution than standard size TV?                                                                                                       [2 marks]
    iii) Describe the principle of motion compensation                                                  [4 marks]
    iv) Explain the difference between I, P and B frames in  MPEG-2                                  [4 marks]

b)  Part of the MPEG-2 compression algorithm uses Huffman coding. Design a  Huffinan code for a source that has the following probabilities of occurrence associated with it: -
    P (Source event 1) = 0.3
    P (Source event 2) = 0.45
    P (Source event 3) = 0.1
    P (Source event 4) = 0.15

    Write down the bit-stream output, given that the following source events occur: -
    3.1.1.2.2.2.4.3.2.1.2.2.4.3.4
                                                                                                            [10 marks]

c)  What do you think might happen to the output bit-rate of an  MPEG-2 encoder if the camera pans left to right
    in a scene? How would the output bit-rate change if the camera zooms in on a scene? Now consider what will happen to the bit-rate if the lighting level in the scene is increased?                    [11 marks]

Question 3

`Kovak' Ltd. produce cameras and film for the domestic market. The company has a reputation for being at the leading edge of technology, and puts in a great deal of time and effort into making its web site helpful and informative. Part of the web site will focus on explaining technology through a series of white papers.

a)  You are charged with writing technical information for the web site on the following: -
    i) What is the difference between the colour representations RGB and YIN?          [3 marks]
    ii) Why is YUV often chosen instead of RGB?                                        [3 marks]
    iii) Explain the principle of operation of a CCD camera                            [2 marks]
    iv) What is the purpose of the gamma function?                                     [2 marks]

b)  Compare and contrast the quality of two still images, one of a piece of text and the other of a continuous tone picture that have both been coded using JPEG, and explain the reasons why this difference in quality occurs. Include in your answer a description of the JPEG compression algorithm.
                                                                                       [11 marks]

c)  JPEG images can be stored on CD-Rs, and `Kovak' Ltd. is offering a discount price on a `special event' album that will be offered on a CD-R and in a traditional paper based version, and will be available only from the web site. Calculate the storage requirements for the `special event' album of 20 still images and a short video sequence, given that:-
    A JPEG Y frame has a resolution of 640 x 480 samples
    Number of bits per sample = 8 bits
    Sub-sampling is in the ration 4:1:1
    The JPEG algorithm gives a bit-rate reduction of 25:1
    Assume that the album has 10 images stored in both uncompressed, and compressed (using JPEG) form, and 10 pictures stored only using JPEG.
    The short video sequence, of 10 seconds worth of video is compressed using moving JPEG at 25 frames per second.
                                                                                       [12 marks]

Question 4

You work for a company that provides networked multimedia conferencing solutions. One of the options that you provide is desktop conferencing over the Internet. Your solutions are accompanied by technical documentation. Produce a technical document for a customer that you have just supplied with a solution, which includes the following: -

a)  i) Why a headset (earphones and microphone) is the preferred option for desktop multimedia conferencing audio?                                                                    [2 marks]
    ii) How the ADPCM algorithm works (include a picture)                              [6 marks]
    iii) What the functions of UDP and RTP protocols are?                             [2 marks]

b)  Calculate the bandwidth required over the Internet for a multimedia conferencing session that includes audio and video.
    Assume that: -
    Audio is coded using SB-ADPCM - input sampling frequency 16kHz, and input bits per sample 16
    Video is coded using H.261 and CIF, which has 352 x 288 pixels per frame, 8 bits per sample, sub-sampling in the ratio 4:1:1, and 5 frames per second. Assume a compression advantage of 25:1.
    Audio is sent in packets that contain 20 ms worth of audio. Video is sent in packets that contain 1024 bytes per packet.
    RTP / UDP / IP header is 40 bytes.                                                [11 marks]

c)  Multimedia conferencing over the Internet incurs a penalty overhead in terms of bandwidth compared to using a network where the audio and video is sent as a bit-stream. Identify the benefits of transmitting over the Internet that offset this disadvantage. Design the software architecture of a system capable of transmitting real-time interactive audio over the Internet.                          [12 marks]

Question 5

a) You are going to set-up a start-up company called `Rapster' which wants to start offering a service that allows users to share their CD collections over the web. You need to write a business case to persuade some venture capitalists that they should fund your company. You are the technical brains in the team, and must write a convincing document that includes the following: -

b) Background information on the MPEG1 Layer 3 music compression algorithm                    [10 marks]

c) An analysis of the quality, bandwidth required to download, and approximate time-to-download factors for potential customers, which compare MPEG3 files to streamed ADPCM music. In order to compare like with like, assume that the time to download the music files occurs at the rate of generation of the music in the first place, plus the overhead for headers.

   Assume:-
       A typical track is 3 minutes long.
       ADPCM for music has a sampling frequency of 16,000Hz, and 4 bits per code word, and packet sizes of 160ms worth of music. RTP headers are 40 bytes long.
       MPEG1 L3 has a sampling rate of 48,000 bits per second, number of bits per sample = 16, and a compression advantage of 12:1. Assume that MPEG1 L3 and IP / TCP headers contribute an increase in the bandwidth of 10%, and assume that the TCP connection rate is at -150 kbps, during the course of your download.

   Compare and contrast the quality of the music transferred as MPEG3 files and streamed using ADPCM coding, giving the technical reasoning behind your analysis. Consider first that there is no loss, and secondly that there is a low rate of IP packet loss experienced over the network.

   Propose the way forward for your start-up, considering the quality, bandwidth required to download, and time to download factors identified above.
                                                                                              [23 marks]