BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI (RAJASTHAN)

Second Semester, 2022-23

Comprehensive Examination

Course Number: CS F401 **Date & Time:** May 20, 2023 (09:30 AM – 12:30 PM)
Course Title : Multimedia Computing **Marks & Nature:** 45 Marks [Closed Book]

All the parts of a question must be answered in continuation and in sequence.
Given: 1 **KB** = 1024 bytes, 1 **kb** = 1000 bits; In ANSI, character A = 65, B = 66, ..., Z = 90, _ = 95, a = 97, b = 98, ..., z = 122.

Q1. Write short and precise answers to the following questions.
1.1 In the context of multimedia operating systems, list and define some QoS parameters?
1.2 Why is the architecture of a multimedia document given in terms of three models?
1.3 Give two differences (in tabular form) between Multimedia Operating System and Real-time System?
1.4 Write two main properties of head mounted displays in the terms of dynamic change of its parameters.
1.5 Why does fractal based compression provide very high compression ratio?

Marks Q1 [1 x 5 = 5]

Q2. Use JPEG compression to compress 3 x 3 block (Table Q2a) and the quantization table (Table Q2b). Determine the compression ratio. Assume that the original data is represented by 8-bit and the Huffman codes (given in the supplied tables) hold good even for a block of size 3 x 3.

Table Q2a

107	109	8
87	75	62
67	40	117

Table Q2b

20	15	10
15	15	10
10	5	5

Marks Q2 [3 + 3 + 1 = 7]

Q3. Assume that a number of co-existing audio signals are available in an array (of structures or similar derived data-types) called "Signals". Assume that two arrays named "Frequency" (float) and "DynamicRange" (float) are used to represent sensitivity (of human ear) as a function of frequency. You are required to store (in an array called "NotAudibles") all those signals, which cannot be heard (by human) when considering the sensitivity of ear as a function of frequency and the effects of frequency masking. Assume that the critical bandwidth for the central frequency, ν, is given by $\nu \pm 0.5*[25 + 75*(1 + 1.4(\nu^2))^{0.69}]$. Develop a computer program to implement the above functionality as the function find_not_audibles(Signals, Frequency, DynamicRange, CntElements, NotAudibles), where CntElements is the number of elements in the Frequency array. You can use any programming language. Use the variable names (case-sensitive) as given, i.e. "Signals", "Frequency", "DynamicRange", "CntElements", and "NotAudibles". All other required variables can be named, as you like. A function, interpolate_min_db(Frequency, DynamicRange, CntElements, AtFrequency), which calculates (or interpolates) DynamicRange for frequency represented by AtFrequency, is to be used in the program. Develop code for the function "interpolate_min_db" as well. **Given:** The value of the function $f(x)$ can be interpolated at $x = X$ using the expression given below:

$$f(X) = \sum_{i=0}^{n} p_i(x_i) f(x_i), \text{ where } p_i(x_i) = \frac{(X - x_0)....(X - x_{i-1})(X - x_{i+1}).....(X - x_n)}{(x_i - x_0)....(x_i - x_{i-1})(x_i - x_{i+1}).....(x_i - x_n)}$$

with given $(n+1)$ values of $f(x_i)$ at $x = x_0, x_1, x_2, \ldots, x_n$.

Marks Q3 [6 + 4 = 10]

Q4. Solve the following. There will be no partial marking in any part of this question.
4.1 Calculate the quantization interval for the signal 1024cos(800t), if 12-bit resolution is used.
4.2 A signal with dynamic range 96 dB has minimum amplitude equal to 5 units. Find the quantization noise, if the quantizer uses 16-bit resolution?
4.3 A fax machine has a resolution of 600 bi-tonal dots per inch along both directions. How many seconds will be required to transmit the contents (in uncompressed form) of an A4-sized (8.5" x 11") paper using 56 kbps line.
4.4 Determine the compression ratio required to transmit a two-hour color movie (with 60 frames per second, at a resolution of 320 x 240, 8-bit per color, and 16-bit 75 samples of audio per second) in 5 minutes over 19.6 kbps line?
4.5 Given the Huffman codes (Table Q4.5), find the string represented by 11111010011001.

4.6 Determine the entropy (correct to 3 decimal places) for the data provided in Table Q4.6.

4.7 Using Table Q4.6, find the first three characters of the arithmetic decoded string given by the number 0.5.

4.8 For a monitor supporting 24-bit color with spatial resolution 1024 x 768, how much data (in MB) is transferred in one hour if the refresh rate is 50 Hz and the digitization format used is 4:2:2?

Table Q4.5

A	B	C	D	E	F	G	H
00	01	10	111	1101	11001	110000	110001

Table Q4.6

Char	A	B	C	D	E	F	G	H
Freq	90	60	50	20	12	8	7	3

Marks Q4 [1.5 x 8 = 12]

Q5. Solve the following problems.

5.1 Using Huffman coding, find the optimized Huffman codes and the compression ratio for the string "our_course_on_multimedia_computing", originally represented with 7-bit ASCII.

5.2 Compress the string "institutional_inning", using LZW compression with 9-bit codes.

5.3 How many heads are there in a hard-disk with storage space of 80 GB? The width of a track is 7.5 μm; width of one bit along circumference is 0.15 μm, with 1.5 cm and 6.0 cm respectively as the inner and outer radii of the writeable area on a head. Assume that a sector stores 512 bytes, and there is no inter-sector and no inter-track gap.

Marks Q5 [2.5 + 2.5 + 3 = 8]

Q6. The following incomplete C program is expected to implement inverse DCT. Complete the program by filling the boxes. Your program must also work correctly when block size (M x N) is changed from 8 x 8 to any other size. There will be no partial marking in any part of this question.

```
#include <stdio.h>
#include <math.h>
#define N 8
#define M 8
#define PI 3.141592654

#define COEFF        Q6.1

Q6.2    ;   /* Function declaration */

Q6.3    inv_dct(float dct[M][N], float INV_DCT[M][N])

{
int u, v, x, y;
float accum, twoN = 2.0*N, twoM = 2.0*M, Cu, Cv, num =    Q6.4    ;
for (x=0; x < M; x++)

for   (y=0,    Q6.5    ; y < N; y++)
   {
        for (u=0; u< M; u++)
          for (v=0; v < N; v++)
            {
            if (u == 0) Cu = COEFF; else Cu = 1.0;
            if (v == 0) Cv = COEFF; else Cv = 1.0 ;
            accum += (Cu*Cv*cos((PI*u*(2*x+1))/twoM)*cos((PI*v*(2*y+1))/twoN)*dct[u][v]);
            }

   INV_DCT[x][y]   =    Q6.6    ;
   }
}
```

Marks Q6 [0.5 x 6 = 3]