



Faculty of Information Technology

Final Exam, 2022/2023(1)

Course Name: Multimedia Computing (COSC 7322)

Instructor: NIZEYIMANA Pierre Celestin

Exam Duration: 2h00

Group : Day

Date :/12/2022

INSTRUCTIONS:

- This paper comprises 8 questions
- Be as short as possible and concise

Multimedia Computing / 40 marks

1. While making a conversion from analog to digital, an audio signal whose frequencies range from 5Khz and 7Khz, was sampled at a rate of 10,000 samples per second. Was this an appropriate sampling rate to use? Why? / **7.5 marks**
According to the Nyquist-Shannon sampling theorem, the sampling rate should be at least twice the highest frequency. In this case, the highest frequency is 7Khz. Therefore, the minimum appropriate sampling rate would be:

Minimum Sampling Rate = 2 * Highest Frequency
Minimum Sampling Rate = 2 * 7Khz = 14,000 samples per second

So, a sampling rate of 10,000 samples per second is not sufficient for accurate representation of the given audio signal with frequencies ranging from 5Khz to 7Khz.

2. If the Y-axis resolution of a converted signal is 5 bits, and the X-axis resolution is 5 Khz, what is the storage requirement of the audio for 5 min? / **7.5 marks**
Data rate = Y-axis resolution * X-axis resolution
Data rate = 5 bits * 5,000 samples/second = 25,000 bits/second

Data rate in bytes/second = 25,000 bits/second / 8 bits/byte = 3,125 bytes/second

Audio duration = 5 minutes * 60 seconds/minute = 300 seconds

Storage requirement = Data rate * Audio duration
Storage requirement = 3,125 bytes/second * 300 seconds = 937,500 bytes

Storage requirement in kilobytes \approx 937,500 bytes / 1024 bytes/kilobyte \approx 915.53 KB

3. One song recorded on an audio CD in un-compressed format, can occupy 35MB, how is that figure arrived at? / **7.5 marks**
The figure of 35MB for an uncompressed audio CD song comes from combining a 44.1 kHz sampling rate, 16-bit depth, and stereo channels. This results in a data

rate of 1,411,200 bits per second. For a 3-minute song (180 seconds), the data size is around 30.28MB. The 35MB estimate may include additional CD-related data.

4. MPEG is based on the concepts of “Spatial redundancy” and “Temporal redundancy”. Which among the following frames are linked with “Temporal redundancy”? Explain. / **7.5 marks**

a) I-frame, b) P-Frame, c) B-Frame.

Temporal redundancy is linked with:

b) P-Frame: Predicts from previous frames.

c) B-Frame: Predicts from both previous and future frames.

These frames use similarities between consecutive frames to compress video data in MPEG.

5. An audio CD played over a phone line, loses quality at the other end of the line, what is the reason behind? / **5 marks**

When an audio CD is played over a phone line, its quality degrades at the receiving end due to the phone line's limited bandwidth, compression used for voice transmission, signal interference and noise, digital-to-analog and analog-to-digital conversion, and signal attenuation over long distances. These factors collectively contribute to a noticeable loss in audio quality compared to the original CD sound. Alternative communication methods with higher bandwidth and less compression, such as VoIP or dedicated audio streaming, can offer better audio quality during transmission.

6. For the below MP3 signal, consider the different intensity levels per sub-band as shown below. Considering the level of loudness in the sub-band 8, will the neighboring sub-band 7 be dropped or kept? Explain / **5 marks**

| | | | | | | | | | | | | | | | | |
|-----------|---|---|----|----|---|---|----|----|----|----|----|----|----|----|----|----|
| Band | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| Level(db) | 0 | 8 | 12 | 10 | 6 | 2 | 10 | 60 | 35 | 20 | 15 | 2 | 3 | 5 | 3 | 1 |

Based on psychoacoustic principles, the strong loudness level in sub-band 8 (60 dB) is likely to mask or reduce the audibility of sounds in neighboring sub-band 7 (10 dB). Consequently, sub-band 7 might be dropped or attenuated during audio compression to optimize perceptual audio quality. The decision depends on encoding parameters and desired audio quality.

<<BEST OF LUCK>>