北京郵電大學

Queen Mary University of London

For examiners' use only

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Total	

EBU5303 A

Joint Programme Examinations 2022/23

EBU5303 Multimedia Fundamentals

Paper A

Time allowed 2 hours

Answer ALL questions

Complete the information below about yourself very carefully.

QM student number										
BUPT student number										
Class number										

Allowed: electronic calculators / Calculator model :

INSTRUCTIONS

1. **You must NOT take answer books, used or unused, from the examination room.**
2. Write only with a black or blue pen **and in English**.
3. Do all rough work in the answer book – **do not tear out any pages**.
4. If you use Supplementary Answer Books, tie them to the end of this book.
5. Write clearly and legibly.
6. **Read the instructions on the inside cover.**

Examiners

Dr Marie-Luce Bourguet, Dr Atm Shafiul Alam

Filename: 2223_EBU5303_A No answer book required

Instructions

Before the start of the examination

1) Place your BUPT and QM student cards on the corner of your desk so that your picture is visible.

2) Put all bags, coats and other belongings at the back/front of the room. All small items in your pockets, including wallets, mobile phones and other electronic devices must be **placed in your bag in advance**. **Possession of mobile phones, electronic devices and unauthorised materials is an offence.**

3) Please ensure your mobile phone is switched off and that no alarm will sound during the exam. **A mobile phone causing a disruption is also an assessment offence.**

4) Do not turn over your question paper or begin writing until told to do.

During the examination

1) You must not communicate with or copy from another student.

2) If you require any assistance or wish to leave the examination room for any reason, please raise your hand to attract the attention of the invigilator.

3) If you finish the examination early you may leave, but not in the first 30 minutes or the last 10 minutes.

4) For 2 hour examinations you may **not** leave temporarily.

5) For examinations longer than 2 hours you **may** leave temporarily but not in the first 2 hours or the last 30 minutes.

At the end of the examination

1) You must stop writing immediately – **if you continue writing after being told to stop, that is an assessment offence.**

2) Remain in your seat until you are told you may leave.

Question 1

a) This question is about digitisation.

[10 marks]

i) Explain what is aliasing and how aliasing can be avoided when digitising a sound signal.

(4 marks)

ii) Calculate the size of a short video clip, **in bytes**, which has the following characteristics: frame dimension 700 pixels x 650 pixels, 12 bits index-based, frame rate 24 frames/s; the audio track contains stereo music digitised at CD quality; the duration is 20 seconds. Show the details of your **calculations**.

(4 marks)

iii) In your opinion, what are the possible implications of choosing a sampling rate that is higher than the Nyquist rate?

(2 marks)

	Do not write in this column
	10 marks

b) This question is about colour encoding.

[15 marks]

i) In the (R, G, B) model, explain how you can decrease the brightness of a colour without changing its hue and saturation. Give an example using an unsaturated blue colour.

(4 marks)

ii) In the (C, M, Y) model, explain how you can increase the saturation of a colour without changing its hue and brightness. Use green as an example.

(4 marks)

iii) What (H, S, V) values would you use to encode a bright yellow colour that is very unsaturated? Explain your choice of values. Now change only one of the three model values to turn the colour into grey.

(4 marks)

iv) What properties of the human visual system have inspired the (R, G, B) colour model?

(3 marks)

	Do not write in this column
	15 marks

Question marking: $\frac{}{10} + \frac{}{15} = \frac{}{25}$

Question 2

a) This question is about digital images.

[13 marks]

i) Define image resolution and explain why vector-based images can always be displayed at high resolution when needed.

(4 marks)

ii) Calculate the size in kilo bytes (kB) of a 200 x 300 pixels true colour image. Now calculate the size of the grayscale version of the same image. What simple method can you use to convert an image from true colour to grayscale?

(4 marks)

iii) Imagine that the RGB colour model is extended to include a fourth value A to encode the opacity of a colour. What would the colour depth of an RGBA image be?

(2 marks)

iv) In your opinion, does conversion from true colour to index-based format always incur some perceived quality loss? Justify your answer.

(3 marks)

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	13 marks

b) This question is about audio encoding.

[12 marks]

i) Why is 44.1 kHz a suitable sampling rate for good quality sound digitisation?

(2 marks)

ii) What are the typical bit depths used for music and for speech respectively, and why are they different?

(4 marks)

iii) Identify three different types of speech sound in the speech spectrogram image shown in Figure 1. Indicate directly on the figure their respective position and their type.

(6 marks)

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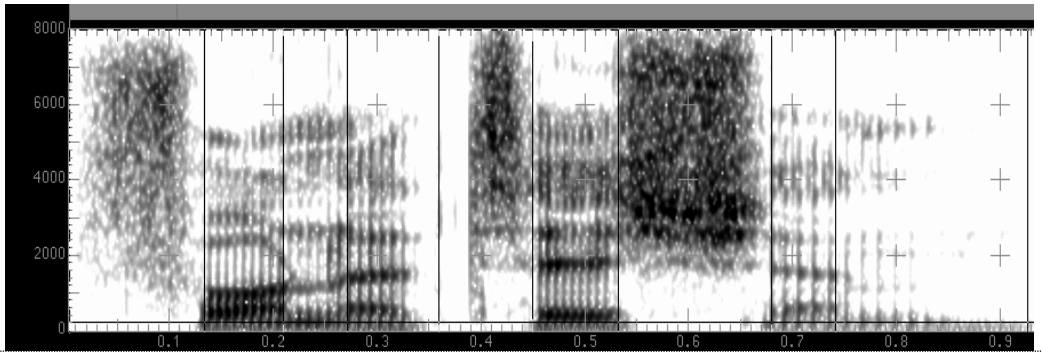 **Figure 1: Speech spectrogram**	
	12 marks

Question marking: $\frac{}{13} + \frac{}{12} = \frac{}{25}$

Question 3

a) This question is about compression.

[13 marks]

i) Give two examples of how the brain deals with the enormous amount of information constantly coming through the senses.

(4 marks)

ii) What image property is used in Run Length Encoding (RLE) to achieve compression? How about Huffman? Are these two compression methods examples of lossless or lossy compression? Justify your answer.

(6 marks)

iii) Consider the sequence of symbols Y, B and G shown in Figure 2 and imagine that a bit depth of 5 is used to encode each symbol. Compress the sequence using RLE. How many bits in total do you need to encode the compressed sequence and how much compression did you achieve?

(3 marks)

Figure 2: Sequence of 5 bits symbols

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	13 marks

b) This question is about image compression using JPEG.

[12 marks]

i) What properties of the human vision system are exploited in JPEG for doing compression? Does it make JPEG lossless or lossy? Justify your answer.

(3 marks)

ii) In JPEG, explain how quantisation works and the implication of choosing a quantisation table with low values.

(4 marks)

iii) State five steps of the JPEG algorithm in the correct order and with brief explanations.

(5 marks)

	Do not write in this column	
		12 marks

Question marking: $\frac{}{13} + \frac{}{12} = \frac{}{25}$

Question 4

a) This question is about video compression using MPEG.

[13 marks]

i) Explain motion estimation and motion compensation. In MPEG, which of the two is done first? Is the Block Matching Algorithm (BMA) and example of motion estimation or motion compensation?

(5 marks)

ii) Compare the processes of motion estimation and motion compensation for the encoding of P and B frames. Why are B frames usually much smaller than P frames?

(4 marks)

iii)The video you want to compress using MPEG contains many fast moving objects. Suggest an appropriate GOP structure and justify your choice.

(4 marks)

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		13 marks

b) This question is about audio perceptual encoding.

[12 marks]

i) Draw a graph representing the threshold of hearing in the presence of a loud 5 kHz sound. Clearly indicate the units on your graph.

(5 marks)

ii) In MP3, what are scaling factors used for? In the presence of a very strong masking tone, would you use a large or a small scaling factor? Justify your answer.

(5 marks)

iii) To achieve an MP3 bitrate of 128 kbit/s, calculate the compression ratio needed for an original stereo CD quality audio signal.

(2 marks)

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	12 marks

Question marking: $\frac{}{13} + \frac{}{12} = \frac{}{25}$

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