EBU5303 A

Joint Programme Examinations 2021/22

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

NOT allowed: electronic dictionaries (calculators are allowed).

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

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.

[7 marks]

i) When you reconstruct a digitised image, you observe some distortions in the patterns that should appear. What happened?

(2 marks)

ii) Calculate the size of a short video clip, **in bytes**, which has the following characteristics: the pixel dimension is 200 pixels x 150 pixels, grayscale, the frame rate is 12 frames/s, the audio track contains speech digitised at 20 kHz and 8 bits/sample, the duration is 30 seconds. Show the details of your **calculations**.

(2 marks)

iii) Open-ended question: is using a very high sampling rate always a good idea? Justify your opinion.

(3 marks)

	Do not write in this column
	7 marks

b) This question is about colour encoding.

[10 marks]

  i)   Explain why RGB is used for colour monitors and CMYK is used for printing.

(4 marks)

  ii)   What (R, G, B) values would you use to encode the brightest magenta colour possible, but one that is very unsaturated? Explain your choice of values.

(3 marks)

  iii) In the (C, M, Y) model, explain how you can increase the saturation of the Cyan colour.

(2 marks)

  iv)   What (H, S, V) values would you use to encode a saturated dark grey colour?

(1 mark)

	Do not write in this column
	10 marks

c) This question is about audio encoding.

[8 marks]

i)   What are the three types of speech sound and how can they be distinguished in a spectrogram?

(4 marks)

ii) Music is usually encoded using a larger bit depth than speech. Explain why and give typical bit depths for music and for speech.

(4 marks)

	Do not write in this column
	8 marks

Question marking: $\dfrac{}{7} + \dfrac{}{10} + \dfrac{}{8} = \dfrac{}{25}$

Question 2

a) This question is about image encoding.

[8 marks]

i) Explain the differences between vector-based, true colour and index-based images.

(4 marks)

ii) Open-ended question: are colour images always better than grayscale images? Justify your opinion.

(4 marks)

	Do not write in this column
	8 marks

b) This question is about data compression.

[8 marks]

i)   Explain in which ways the human brain is a powerful compressor.

(4 marks)

ii) What is the difference between information and data? What is redundancy?

(3 marks)

iii) Can text data be compressed? If yes, give an example of text compression technique.

(1 mark)

	Do not write in this column
	8 marks

c) This question is about lossless image compression.

[9 marks]

i) Why is lossless data compression not always possible?

(2 marks)

ii) You are compressing a grayscale image (the bit depth is 8) using RLE. The pixel dimension is 1800x1500 pixels. The first two thirds of a row of pixels are dark grey and the rest is light grey (see Figure 1). How many bytes are needed to encode each row of pixels if you consider that a row contains exactly two runs? What compression rate can you achieve for that image? Show your calculations.

Hint: Use the same number of bytes to encode the size of each run.

Figure 1

(4 marks)

iii) Recalculate the compression rate you can achieve when the size of a run is fixed to one byte. Show your calculations.

(3 marks)

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	9 marks

Question marking: $\dfrac{}{8} + \dfrac{}{8} + \dfrac{}{9} = \dfrac{}{25}$

Question 3

a) This question is about JPEG.

[13 marks]

i) Draw a simple flow chart diagram showing all the steps of the JPEG compression algorithm.

(5 marks)

ii) Propose a chroma sub-sampling scheme which would reduce the size of the image to half its original size. Prove that the size is reduced to half and illustrate your answer with a drawing.

(4 marks)

iii) Which step of the JPEG algorithm removes the high frequencies? How does it work?

(4 marks)

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	13 marks

b) This question is about video compression.

[12 marks]

   i)   A video frame can be compressed more heavily than a single still image. Why and how does it work?

(3 marks)

   ii) Draw a valid 9 frame GOP in the display order, showing the dependencies between frames. Now draw the same GOP in the transmission order. Why are the two orders different?

(4 marks)

   iii) How does the motion estimation block-matching algorithm work? Propose solutions for making it faster.

(5 marks)

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	12 marks

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

Question 4

a) This question is about audio perceptual encoding.

[15 marks]

   i) Explain what is the "threshold of hearing in quiet". Illustrate your answer with a 2D graph, indicating what is represented on each axis.

(4 marks)

   ii) Redraw your illustration of the threshold of hearing in the presence of a loud 1KHz sound. Comment your drawing.

(3 marks)

   iii) Let us assume that an uncompressed band value is 15,000 and values from all bands are quantised by dividing by 128 and rounding down. What is the quantisation error? Show your calculations.

(3 marks)

   iv) Now suppose that this band requires less precision because of a strong masking tone, and that it should be scaled by a factor of 0.2. Recalculate the quantisation error.

(3 marks)

   v) With an MP3 bitrate of 320 kbit/s, calculate the compression ratio that is achieved on a music signal sampled at 44.1KHz and with a bit depth of 16.

(2 marks)

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	15 marks

b) This question is about digital broadcasting.

[10 marks]

i) Explain what digital broadcasting is and illustrate your answer with a drawing.

(2 marks)

ii) Describe the MPEG-2 Transport Stream (MPEG-TS).

(4 marks)

iii) Give one example of channel coding technique. Explains its purpose and principle.

(4 marks)

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	10 marks

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

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