COMP 28512

Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Mobile Systems

Date: Tuesday 28th May 2019

Time: 14:00 - 16:00

Please answer all THREE Questions
Each question is worth 20 marks

This is a CLOSED book examination

The use of electronic calculators is permitted provided they are not programmable and do not store text

[PTO]

1. **This question refers to most sections of the course. Each part is worth 2 marks.**

a) What are the properties of flash memory and dynamic random access memory (DRAM) as used by smart-phones?

b) Explain what is meant by aliasing, and explain how this may affect the sound of a musical instrument.

c) Explain how a Fourier series may be expressed in modulus and phase form in terms of sinusoids and explain what is meant by a line-spectrum.

d) What are the main properties of Huffman coding as used for psycho-acoustic music (mp3) encoding and also for JPEG image encoding?

e) What is meant by interleaving as may be applied when transmitting a sequence of ASCII characters over a radio channel? Why is it beneficial when using forward error correction (FEC)?

f) State and briefly explain the 'multiple-access' mechanisms used by second generation (2G) and third generation (3G) mobile telephony for sharing the available radio spectral band within each cell among many transmitters.

g) What is the difference between 1 persistent CSMA and non persistent CSMA? Which is more efficient in terms of (i) throughput per packet time (channel utilisation) and delay.

h) What is a watch-dog timer?

i) Explain how buffering is used in streaming multimedia communications. If a 2 minute video-clip encoded using MPEG-1 at 1.2 Mbit/s is being downloaded to your mobile phone at 1 Mbit/second, what length of buffer would allow you to watch it in real time without interruptions (frame freezing)? How much delay would this cause before the video-clip starts to play?

j) Why must both energy consumption and power consumption be limited in the operation of smartphones?

2. This question is concerned with speech digitisation and bit-error control

a) Explain the difference between:

i) uniform and non-uniform quantisation (2 marks)
ii) waveform coding and parametric coding (2 marks)

as applied to the digitisation of speech.

b) Why do stereophonic compact disc recordings generally use in excess of 1,400,000 bits/second, while fixed telephones are able to transmit speech using 64,000 bits per second and mobile telephones can transmit acceptable speech using only 13,000 bits per second? How is bit-rate saving achieved for fixed and mobile telephony? (6 marks)

c) Why is the use of forward error correction (FEC) more important with mobile systems using wifi and cellular radio than with systems that use wired connections? How does the use of forward error correction (FEC) in cellular mobile telephone systems increase their energy efficiency and also the effectiveness of spatial multiplexing by frequency re-use? (4 marks)

d) A 4-bit integer M_3 M_2 M_1 M_0 is Hamming coded by including three additional bits P_2, P_1 and P_0 to allow the correction of any single bit-error that may result from its radio transmission by a mobile system. Show how a suitable set of three additional bits may be derived for the given 4-bit integer and explain how the correction would be done, if necessary, at the receiver. (6 marks)

3. This question is about cellular networks and Image compression

a) Explain the principle of cellular spatial multiplexing as used by mobile telephony. (3 marks)

b) Explain the terms 'circuit switching' and 'packet switching' as applied to mobile telephony. What are the main advantages and disadvantages of each of these mechanisms? Which of these mechanisms are used for voice communications by second (2G) and third (3G) generation mobile telephony? How does 4G telephony deal with voice traffic currently and how may this change in future? (7 marks)

c) Why are 'RGB' encoded images converted to luminance and chrominance form when representing them as JPEG files? In principle how is the conversion to luminance and chrominance achieved? (2 marks)

d) Explain how a coloured still image in 640 by 480 pixel bit-map form may be converted to a compressed image in JPEG form. (6 marks)

e) Why would you expect a JPEG compressed image to be more sensitive to the effect of bit-errors than an uncompressed image such as a bit-map? (2 marks)

END OF EXAMINATION