University of Glasgow

James Watt School of Engineering

Degrees of MEng, BEng, MSc and BSc in Engineering

ENG3014 Communication Systems 3

Thursday, 07 December 2023, 13:30-15:00

Attempt ALL questions.

TOTAL MARKS AVAILABLE
50

The numbers in square brackets in the right-hand margin indicate the marks allotted to the part of the question against which the mark is shown. These marks are for guidance only.

An electronic calculator may be used provided that it does not have a facility for either textual storage or display, or for graphical display.

OVER

Q1 In spectral band limited communications, it is important to consider the frequency components contained within any signal transmitted over the system.

(a) Explain the difference between Fourier Series, Fourier Transform and Discrete Fourier Transforms. For each, specify where each can be used to analyse the frequency components of a signal. [6]

(b) In radio communication schemes, we commonly use a carrier frequency, which is subsequently modulated to carry the information. Explain the meaning of the following terms: (i) baseband and (ii) sidebands. As part of your answer explain how the Nyquist sampling limit is different for measuring the baseband signal compared to signal sidebands. [6]

(c) Considering an amplitude modulated signal, draw a plot for the amplitude modulated signal. Chose a suitable carrier and modulation frequency for a single tone being transmitted over the channel with a DC bias of 1V. [6]

(d) Draw a plot of the Fourier Transform for the single tone in (c). Describe what happens when you reduce the DC value to 0 and explain what will happen to peaks in the diagram. [3]

(e) Draw the plot of the Fourier Transform for a dual-tone signal being transmitted with one at a harmonic frequency of the tone used in (c). Please explain any differences in the carrier and channel bandwidth required two transmit both frequencies. [3]

(f) A filter circuit will change the signal measured. Explain what we will see in the time domain of the signal from (d) when it is connected to a filter circuit, centred on the carrier frequency and has a bandwidth of:

(i) half the lowest frequency tone

(ii) twice the lowest frequency tone

(iii) and six times the lowest frequency tone [3]

Continued overleaf

Q2 Coding can be used to detect if errors in transmission have occurred.

(a) Explain what parity bits are used for in the coding of information and give an example of binary sequence that includes a single parity bit. [3]

(b) Using 7:4 Hamming coding, code a suitable message and determine the binary sequence that would be transmitted in a communication system. [4]

(c) A binary sequence (1 0 1 1 0 1 1) is received using a systematic ordered Hamming code. Determine if this is an error free message. If not, determine the location of the bit error and correct the message.
[4]

Continued overleaf

Q3 Optical fibre transmission is used for high-speed communications.

(a) Describe why fibers are used for high-capacity communications and why an optical carrier is important for the high data rate achievable. [2]

(b) Describe what governs the spectral efficiency of the fibre transmission system with signals with an optical power of 10dBm in fibre and discuss the approaches available to maximise the spectral efficiency of a fibre communication system. [2]

(c) Describe the differences between optical transmission in single mode, step-index multimode and graded index fibre. Use an appropriate diagram to support your description of the propagation of light for each fibre type. [5]

(d) Discuss what limits the data rate in step-index multimode fibre and how this varies with respect to graded index fibre. [3]

End of question paper