Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 2, 2018					

ENG473 – Communication Systems	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

- Exam has five questions.
- Answer all questions of the exam.
- Exam has 65 marks.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a RESTRICTED OPEN BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
Lecture Textbook/s (Unannotated)	1 x 20 Page Book 1 x Scrap Paper Formula Sheet/s

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

Question 1 (10 marks)

An ideal channel has a bandpass frequency response in the range of 10MHz-50 MHz.

a) Design a 64 QAM system for transmitting data of rate 1Mbit/sec and a carrier frequency f_c=20MHz. For spectral shaping, apply a raised cosine frequency response characteristic with roll-off factor of 1. In your design, assume spectral is evenly split between transmitter and receiver filter. (7 marks)
b) Sketch a block diagram of the system and describe its functional operation. (3 marks)

Question 2 (15 marks)

Consider an M-ary FSK system, which can transmit m signals represented as $u_m(t)=\sqrt{\frac{2E_s}{T}}\sin(2\pi f_c t + 2\pi m\Delta f t)$, $0 \le t \le T$, $1 \le m \le M$. In these signals, f_c and Δf denote the carrier frequency and frequency separation between successive frequencies. Assume $u_0(t)$ is transmitted through the AWGN channel and demodulated by the phase coherent technique. Determine the output of M-1 correlators at t=T that is relevant to the signals $u_m(t)$, m=1,2,…,M-1 when $\hat{\phi}_m \neq \phi_m$.

Question 3 (8 marks)

Digital information is modulated by four-frequency orthogonal FSK and transmitted through an AWGN channel with a bandwidth of 500KHz.

a) What is the maximum transmission rate of the information?(2 marks)
b) What is the probability of a bit error for E_b/N_0=4 dB? (6 marks)

Question 4 (17 marks)

The parity check matrix of a (7,3) linear block code is given by:

$$H=\begin{bmatrix} 1&1&0&1&0&0&0 \\ 0&1&1&0&1&0&0 \\ 0&0&1&1&0&1&0 \\ 0&0&0&1&1&0&1 \\ 1&0&0&0&1&1&0 \\ 0&1&0&0&0&1&1 \\ 1&0&1&0&0&0&1 \end{bmatrix}$$

a) Draw the Tanner graph of this code. (4 marks)
b) Determine the girth of the code. Prove your answer by using the Tanner graph drawn in part (a). (3 marks)
c) Let C=[0 1 0 1 0 0 1] be the bitstream at the input of the decoder. Apply bit flipping decoding technique and determine the codeword obtained at the output of decoder. You are required to provide all decoding steps. (10 marks)

Question 5 (15 marks)

For the (15,7) cyclic code with $g(x) = x^8+x^7+x^6+x^4+1$, answer the following questions:

a) Determine the parity check polynomial of the code. (5 marks)
b) Draw the shift-register based encoder of this code. (3 marks)
c) A communication system applies this code for transmission of the original information with rate of 10 Mbits/sec. Codewords modulated by the binary PSK are transmitted through AWGN channel with the power of 1.5 milliWatt and power spectral density of $\frac{N_0}{2} = 10^{-11}$ Watt/Hz. Determine the block error probability of the system with and without (15,7) code. (7 marks)

Some Formulas:

$\sin\alpha \sin\beta = \frac{1}{2}\cos(\alpha-\beta) - \frac{1}{2}\cos(\alpha+\beta)$

$\cos\alpha \cos\beta = \frac{1}{2}\cos(\alpha-\beta) + \frac{1}{2}\cos(\alpha+\beta)$

$\sin\alpha \cos\beta = \frac{1}{2}\sin(\alpha-\beta) + \frac{1}{2}\sin(\alpha+\beta)$