GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY
Faculty of Engineering
Department of Electrical, Electronic and Telecommunication Engineering

B.Sc. Engineering Degree
Semester 6 Examination – September 2024
(Intake 39 - ET)

ET3223 – COMMUNICATION THEORY II

Time allowed: 3 Hours — 12 September 2024

ADDITIONAL MATERIAL PROVIDED

Page 6 USEFUL FORMULAE

INSTRUCTIONS TO CANDIDATES

This paper contains 5 questions and answer all the questions on answer booklets.

This paper contains 6 pages with the cover page.

This is a closed book examination

This examination accounts for 70% of the module assessment. The marks assigned for each question and parts thereof are indicated in square brackets

If you have any doubt as to the interpretation of the wordings of a question, make your own decision, but clearly state it on the script

Assume reasonable values for any data not given in or provided with the question paper, clearly make such assumptions made in the script

All examinations are conducted under the rules and regulations of the KDU

DETAILS OF ASSESSMENT

Learning Outcome (LO)	Questions that assess LO	Marks allocated (Total 70%)
LO1	Q1, Q2	15
LO2	Q2, Q3	20
LO3	Q2, Q3	10
LO4	Q4	20
LO5	Q5	05

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$\int_0^T \left(1 - \right) e^{-j2\pi f t}\, dt$

$\frac{-e^{-j2\pi fT}}{j2\pi f}$

Question 1

(a) Explain the various applications of baseband transmission. [04]

(b) Explain baseband pulse transmission using the diagram. [04]

(c) A matched filter has the frequency response

$$H(f) = \frac{1 - e^{-j2\pi fT}}{j2\pi f} \Rightarrow \int_0^\infty h(t)\, e^{-j2\pi f T}\, dt$$

i. Identify the h(t) [04]
ii. Identify the signal waveform s(t) to which this filter is matched. [04]
iii. If s(t) is applied to the input of the matched filter, what is the peak value of the match filter output? [04]

Question 2

$\frac{1 - e^{-j2\pi f t}}{j2\pi f t}$ $\frac{1 - 8\cos 2\pi f t + j\sin 2\pi f t}{j2\pi f t}$

(a) Explain the pulse code modulation and the steps which are involved in the PCM process. [04]

(b) T_1 carrier system used to multiplex 24 independent voice inputs, based on an 8-bit PCM word. It was shown that the bit duration of the resulting time-division multiplexed signal (including a framing bit) given that T_b=0.647 µs.

i. Assuming the use of an ideal Nyquist channel, calculate the minimum transmission bandwidth? [04]
ii. What is the transmission bandwidth for a full cosine roll off characteristics with α=1. [04]

(c) A communication system transmits data at a rate of 1 Mbps over a noisy channel which has bandwidth 1 MHz. The channel has a signal-to-noise ratio (SNR) of 3.52 dB. Calculate the probability of symbol error for this system. It is given that and λ=0 and and P_1=P_0=0.5. [04]

(d) The average power received in a BPSK transmission is 10mW, and the bit period is 100μs. If the noise power spectral density is 0.1μJ, and coherent detection is used, determine the bit error rate. [04]

(e) In M-ary PSK, the carrier takes one of possible values from equation. State all the phase of the carriers for M=8. [04]

$$\theta_i = \frac{2(i-1)\pi}{M}$$

(f) During each signaling point with M =8. The transmitting signal,

$S_i(t) = \sqrt{\frac{2E_s}{T}} \cos(2\pi f c t) + \frac{2\pi}{M}(i-1)$ where i = 1, 2,...... M . E_s is the energy per symbol and f_c is the carrier frequency.

List down all the possible signals that can be transmitted. [04]

Question 3

In an Amplitude Shift Keying (ASK) System symbol '1' is represented by $s(t) = A_c\cos(2\pi f_c t)$ and symbol '0' is represented by switching off the carrier.

(a) Show the sinusoidal carrier of amplitude of s(t) is $A_c = \sqrt{\frac{2E_b}{T_b}}$. Where E_b is the energy per bit and T_b is the bit duration. [04]

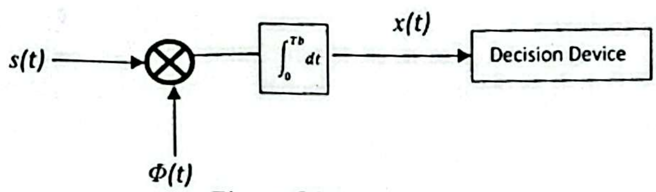

Figure Q3.1

Figure Q3.1 shows a coherent reception scenario for an AWGN channel with zero mean and variance of $\frac{N_o}{2}$. Where $\phi(t)=\sqrt{\frac{2}{T}}cos(2\pi fct)$ and in the decision device if $x(t) > \frac{E_b}{2}$ the receiver decide in favor of symbol 1 and $x(t) < \frac{E_b}{2}$ the receiver decide in favor of symbol 0.

(b) Compute the value of x(t). [05]

(c) Find the conditional probability of the receiver deciding in favor of symbol x given that '1' was transmitted. [03]

(d) Find the conditional probability of the receiver deciding in favor of symbol x given that '0' was transmitted. [03]

(e) Show that the average probability of error for this ASK system is $\frac{1}{2}erfc(\frac{1}{2}\sqrt{\frac{E_b}{N_o}})$.[05]

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Question 4

(a) For a discrete memoryless source, there are three symbols with $P_1 = \alpha$ and $P_2 = P_3$. Find the entropy of the source. [05]

(b) Draw the Huffman tree corresponding to the alphabet with probabilities for symbols table below in Table Q4.1. [08]

Table Q4.1

S_1	S_2	S_3	S_4	S_5
0.4	0.2	0.2	0.1	0.1

(c) Based on the derived Huffman tree in part (b) answer the following questions.

i. Find the average code word length. [03]
ii. Find the entropy of the source. [03]
iii. Calculate the efficiency of the code. [03]
iv. Calculate the Redundancy of the code. [02]

Question 5

Consider the following generator matrix G of (6, 3),

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

(a) Find all corresponding code words. [03]

(b) Let's assume the derived codewords in part (a) is sent over a noisy channel, and received word is r = (1 0 0 0 1 1) that has a single error. Determine the error syndrome. [05]

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USEFUL FORMULAE

Complementary Error Function

$$\mathrm{erfc}(z) = 1 - \mathrm{erf}(z)$$

$$= \frac{2}{\pi} \int_{z}^{\infty} e^{-t^2}$$

Trigonometric formulae

$\sin(A \pm B) = \sin(A)\cos(B) \pm \cos(A)\sin(B)$
$\cos(A \pm B) = \cos(A)\cos(B) \mp \sin(A)\sin(B)$
$\tan(A \pm B) = (\tan(A) \pm \tan(B)) / (1 \mp \tan(A)\tan(B))$

$\sin(2A) = 2\sin(A)\cos(A)$
$\cos(2A) = 2\cos^2(A) - 1 = 1 - 2\sin^2(A)$
$\tan(2A) = 2\tan(A) / (1 - \tan^2(A))$

$2\cos(A)\cos(B) = \cos(A+B) + \cos(A-B)$
$2\sin(A)\cos(B) = \sin(A+B) + \sin(A-B)$
$2\sin(A)\sin(B) = \cos(A-B) - \cos(A+B)$

The probability density function of a Gaussian distribution with expected value μ and variance σ^2 is

$$g(x) = \frac{1}{\sigma\sqrt{2\pi}} exp\ \left(-\frac{1}{2}\frac{(x-\mu)^2}{\sigma^2}\right)$$

End of question paper