UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: February 2020

Module Number: EE4301 **Module Name: Communication Systems I**

[Three Hours]

[Answer **all questions**, each question carries 10 marks]

Q1 a) i) Briefly explain how a typical analog communication system and a digital communication system differ from each other. List main components of each system and their functionalities to support your answer.

[3 Marks]

ii) Various unwanted and undesirable effects occur during signal transmission over a communication channel. The noise effect is an example and it is modeled as Additive White Gaussian Noise. Explain what you understand by the term Additive White Gaussian Noise.

[2 Marks]

b) A received signal of a binary communication system is given by

$$r = \begin{cases} A + n, & \textit{when binary '1' is transmiited} \\ n, & \textit{when binary '0' is transmitted} \end{cases}$$

'A' is a constant and 'n' is a zero mean Gaussian random variable with variance σ_n^2. The probability density function of n is given by $p(n) = \frac{1}{\sqrt{2\pi\sigma_n^2}} e^{-n^2/2\sigma_n^2}$. If $r > k$, the decision at the receiver is '1'. Otherwise, the decision is '0'. Here, k is the decision threshold.

i) Determine a suitable value for the decision threshold k to recover the transmitted binary symbols with minimum error.

[1 Mark]

ii) Compute the total error probability of this communication system. Assume, the transmitter of the communication system produces binary '1' and '0' with equal probability.

[**Hint:** The tail integration of a Gaussian probability density function p(x) can be approximated by $Q(x) = \frac{1}{\sqrt{2\pi}} \int_x^\infty e^{-y^2/2}\, dy$].

[4 Marks]

Q2 a) The message signal $m(t) = 2\cos(20\pi t)$ is passed through the modulation system shown in Figure Q2.a with f_c = 500 Hz. Assume A= 2.

i) What type of modulation does this system perform?

[1 Mark]

ii) Write mathematical expressions for the time domain and frequency domain representations of the output signal $s(t)$ shown in Figure Q2.a.

[2 Marks]

iii) Sketch the output signal $s(t)$ and it's spectrum. Clearly indicate the important points in the diagram.

[2 Marks]

b) Assume that you are asked to modify the modulation system shown in Figure Q2.a in order to obtain the output signal $s(t) = \cos(980\pi t)$.

i) What are the modifications needed to be done to the system to obtain the given output signal. You may add additional components to the system, if required.

[2 Marks]

ii) What type of modulation scheme does this modified system perform?

[1 Mark]

iii) Briefly explain the advantages and disadvantages of the modified modulation scheme compared to the one in part a) i).

[2 Marks]

Q3 a) An envelope detector is used to demodulate conventional Amplitude Modulated waveform. The frequency of the message signal $m(t)$ is $f_m = 1$ KHz and the frequency of the carrier signal $c(t)$ is $f_c = 100$ KHz.

i) Draw the circuit diagram of an envelope detector that consists of a diode (D), a capacitor (C) and a load resistor (R).

[2 Marks]

ii) Briefly explain the operation of the envelope detector drawn in part a) i) when tracing the envelope of the modulated waveform.

[2 Marks]

iii) If the load resistance of the resistor R = 10 kΩ, determine a suitable value for the capacitance of the capacitor C. Assume that the diode D is an ideal diode.

[3 Marks]

b) Envelop detector is one of the two main components in a frequency discriminator which is used to demodulate FM signals.

i) What is the other main component of the frequency discriminator?

[1 Mark]

ii) Explain the main functionality of the component given in the part b) i).

[2 marks]

Q4 a) i) Briefly explain sampling, quantization and encoding operations performed in a Pulse Code Modulation (PCM) system.

[2.5 Marks]

ii) Briefly explain the difference between uniform quantization and non-uniform quantization used in digital communication systems.

[2.5 Marks]

b) Consider the line coded output waveform of a PCM system as shown in Figure Q4.a. Assume that gray coding is used to encode the quantized signal and the size of a code word is three bits.

i) What type of line code does this waveform represent?

[1 Mark]

ii) Determine the Natural Binary Codes corresponding to the waveform shown in Figure Q4.a.

[2 Marks]

iii) Determine the quantized version of the analog signal from which this signal is derived. Assume uniform quantization is performed in the PCM system.

[2 Marks]

Q5 a) i) Briefly explain the difference between digital baseband modulation techniques and digital passband modulation techniques.

[2 Marks]

ii) Briefly explain the difference between Binary Amplitude Shift Keying (ASK) and Binary Frequency Shift Keying (FSK) modulation schemes.

[2 Marks]

b) "M-ary Phase Shift Keying (MPSK) modulation schemes can conserve the bandwidth compared to the Binary Phase Shift Keying (PSK) modulation scheme".

i) Do you agree with the above statement? Use appropriate equations to support your answer.

[3 Marks]

iii) Draw BPSK and QPSK modulated signals corresponding to the binary sequence "1101100011".

[3 Marks]

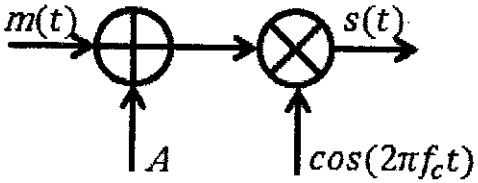

Figure Q2.a : Modulation System.

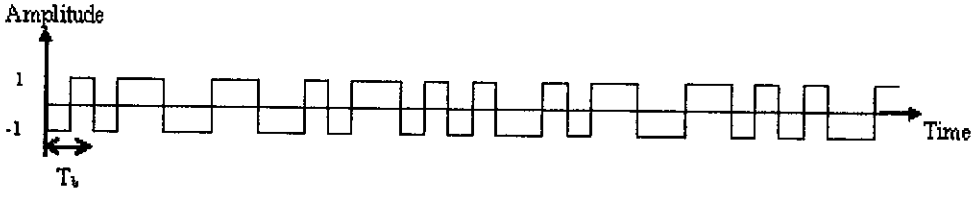

Figure Q4.a : Output Waveform of a PCM System.