Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	DIGITAL COMMUNICATION
COURSE CODE	:	BNF 36103
PROGRAMME CODE	:	BNF
EXAMINATION DATE	:	DECEMBER 2019 / JANUARI 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Digital communication systems are becoming increasingly attractive because of the ever-growing demand for data communication and because digital transmission offers data processing options and flexibilities not available with analog transmission. Give **THREE (3)** advantages of digital systems that can be compared to the analog systems.

(3 marks)

(b) The spectral density of a signal characterizes the distribution of the signal's energy or power in the frequency domain. This concept is particularly important when considering filtering in communication systems.

(i) Explain how can power spectral density of non-periodic signal be calculated.

(2 marks)

(ii) Calculate the average normalized power in the waveform, $x(t) = A\cos 2\pi f_0 t$, using time averaging.

(3 marks)

(c) Describe the similarities and differences between the terms "formatting" and "source coding"

(3 marks)

(d) In the compact disc (CD) digital audio system, an analog signal is digitized so that the ratio of the peak-signal power to the peak-quantization noise power is at least 96 dB. The sampling rate is 44.1 kilosamples/s.

(i) Calculate how many quantization levels of the analog signal are needed for $(S/N_q)_{peak} = 96\ dB$

(5 marks)

(ii) Determine how many bits per sample are needed for the number of levels found in **Q1(d)(i).**

(2 marks)

(iii) Estimate the data rate in bits/s.

(2 marks)

Q2 (a) The task of the detector is to retrieve the bit stream from the received waveform, as error free as possible, notwithstanding the impairments to which the signal may have been subjected.

(i) Describe the primary causes for error-performance degradation in communication systems.

(2 marks)

(ii) Define the term "additive white Gaussian noise (AWGN)". Is Gaussian noise always white?

(2 marks)

(b) Determine the probability of bit error, P_B, for the coherent matched filter detection of the equally likely binary FSK (Frequency-shift keying) signals

$$s_1(t) = 0.5\cos 2000\pi t$$

and

$$s_2(t) = 0.5\cos 2020\pi t$$

where the two-sided AWGN power spectral density is $N_0/2 = 0.0001$. Assume that the symbol duration is $T = 0.01\ s$.

(6 marks)

(c) In wireless communication, information is transmitted by encoding voice and data on radio waves of certain frequencies. List **FOUR (4)** coherent modulation techniques.

(4 marks)

(d) The constellation diagrams for an '8-APK' modulator and an '8-PSK' modulator are shown in **Figure Q2(d).** Sketch the waveform produced by each of the schemes when the 3 kb/s bit-stream is as follows:

0 0 0 1 1 0 0 1 1 1 0 1

and the carrier frequency is 2 kHz. The effect of band-limiting and pulse-shaping need to be shown.

(6 marks)

Q3 (a) Illustrate the waveform and vector representation for antipodal and orthogonal signals with analytic representation as follow:

(i) Antipodal signal

$$S_1(t) = \sin \omega_0 t \qquad 0 \leq t \leq T$$

$$S_2(t) = -\sin \omega_0 t \qquad 0 \leq t \leq T$$

(ii) Orthogonal signal

$$S_1(t) = p(t) \qquad 0 \leq t \leq T$$

$$S_2(t) = p\left(t - \frac{T}{2}\right) \qquad 0 \leq t \leq T$$

(6 marks)

(b) Describe Reed-Solomon (R-S) codes in channel coding.

(3 marks)

(c) Explain why Reed Solomon (R-S) codes perform so well in a bursty-noise environment.

(5 marks)

(d) A coded orthogonal BFSK modulated signal is transmitted over a Gaussian channel. The signal is noncoherently detected and hard-decision decoded. Calculate the decoded bit error probability if the coding is a hamming (7, 4) block code and the received E_b/N_0 is equal to 20.

(6 marks)

Q4 (a) As a designer for a communication system, identify **SIX (6)** goals that need to be considered in designing the system.

(6 marks)

(b) Define Shannon-Hartley Capacity Theorem. State the equation of the theorem.

(4 marks)

(c) Entropy is defined as the average amount of information per source output. Calculate the average information in bits / character for the English language. Assume that each of the 26 characters in the alphabet occurs with equal likelihood. Neglect spaces and punctuation.

(4 marks)

(d) Assume that a data stream with data rate R=144 Mbits/s is to be transmitted on an RF channel using DSB modulation scheme. Assume Nyquist filtering and an allowable DSB bandwidth of 36 MHz.

(i) Based on **Figure Q4(b)**, propose the suitable modulation technique for this requirement.

(4 marks)

(ii) If the available E_b/N_0 is 20, calculate the bit error probability.

(2 marks)

Q5 (a) Phase Locked Loop (PLL) has three basic components; a phase detector, a loop filter and a voltage-controlled oscillator (VCO).

(i) Draw a basic schematic diagram for Phase Locked Loop (PLL)

(3 marks)

(ii) Interpret the function of each of the components

(3 marks)

(b) Determine the upper bounds on squaring loss S_L for second and fourth power loops, respectively, for an input loop signal to noise ratio, ρ_i of 10 dB

(6 marks)

(c) Transmitter synchronization procedures may be classified as being either open loop or closed loop. Summarize the advantage and disadvantage for open loop and closed loop methods in transmitter synchronization.

(8 marks)

- **END OF QUESTIONS** -