ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

SECOND SEMESTER EXAMINATION, 2017/2018 ACADEMIC SESSION

COURSE TITLE: DIGITAL COMMUNICATION

COURSE CODE: EEE 524

EXAMINATION DATE: 8TH AUGUST 2018

COURSE LECTURER: PROF. O. AKINSANMI

HOD's SIGNATURE

TIME ALLOWED: 3 HOURS

INSTRUCTIONS:

1. ANSWER FIVE QUESTIONS ONLY
2. SEVERE PENALTIES APPLY FOR MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM.
3. YOU ARE **NOT** ALLOWED TO BORROW ANY WRITING MATERIALS DURING THE EXAMINATION.

QUESTION 1

(a) Explain the term "*Digital Communication*", and mention five (5) major constraints associated with the design of a digital communication system. **[4marks]**

(b) Draw a block diagram of a digital communication system, and explain the major components that relate to any communication system. **[4marks]**

(c) The output of a discrete memoryless source (DMS) with corresponding probabilities is as shown: $x_1 = 0.05, x_2 = 0.15, x_3 = 0.20, x_4 = 0.05, x_5 = 0.15, x_6 = 0.30,$ and $x_7 = 0.10$.

(i) Design a Huffman coding algorithm for this source.

(ii) Calculate the efficiency of the code. **[4marks]**

QUESTION 2

(a) State 3 important parameters of a channel **[3marks]**

(b) The input to a binary communication system denoted by a random variable X takes on one of two values 0 and 1 with probabilities $\frac{5}{7}$ and $\frac{2}{3}$ respectively. Due to errors caused by noise in the system, the output Y differs from the input X occasionally. The behaviour of the communication system is modelled by the conditional probabilities: $P(Y = 1|X = 1) = \frac{1}{2}$ and $P(Y = 0|X = 0) = \frac{3}{10}$

(i) Find P(Y=1) and P(Y= 0)..

(ii) Find $P(X = 1|Y = 1)$ and $P(X = 0|Y = 0)$.

(c) The Table R1 below shows the output of a Discrete Memoryless Source (DMS) and codes. Classify each code as distinct, uniquely decodable and instantaneously decodable. **[5marks]**

Table R1

Source Symbol	$P(x_i)$	Code 1	Code 2	Code 3	Code 4	Code 5	Code 6
x_1	½	0	0	00	0	0	0
x_2	¼	0	1	01	01	10	10
x_3	1/8	1	00	10	011	110	110
x_4	1/8	11	11	11	0111	1110	111

QUESTION 3

(a) Define the term "Entropy" of a discrete memoryless source (DMS). **[2marks]**

(b) The symbols produced by an information source are the two digit octal numbers 00, 01, 02, 77 and they have probability of occurrence. Determine the entropy of this source. Calculate the information conveyed, when a symbol from this source is received and

(i) It has two different digits.

(ii) It has both digits the same.

(iii) It is odd. **[6marks]**

(c) A computer user plans to buy a higher speed modem for sending data over his her analog telephone line. The telephone line has a signal-to-noise ratio of 25dB and passes audio frequencies over the frequency range 300Hz to 3200Hz. Calculate the maximum data rate that could be sent over the telephone line without errors at the receiving end. **[4marks]**

QUESTION 4

(a) State the sampling theorem, and list any four advantages of a Pulse Code Modulation (PCM). **[4marks]**

(b) A band-limited signal has a bandwidth of B Hz and a sampling frequency of F_s. Explain with aid of simple diagrams whether or not the original spectrum can be recovered, if:

(i) $F_s > 2B$

(ii) $F_s = 2B$ and

(iii) $F_s < 2B$ **[6marks]**

(c) State Channel Coding Theorem. **[2marks]**

QUESTION 5

(a) Define the term 'modulation' and outline three possible challenges that a system designer may likely confront, if the baseband signal must be transmitted without modulation. **[4marks]**

(b) Briefly explain any three of the pulse modulation techniques. **[4marks]**

(c) A discrete memoryless source (DMS) has an alphabet of eight letters x_i where $i = 1, 2, \ldots 8$, with probabilities 0.25, 0.20, 0.15, 0.12, 0.10, 0.08, 0.05, and 0.05 respectively.

(i) Design a Huffman encoding procedure for the source output.

(ii) Determine the efficiency of the source output; hence or otherwise classify the code. **[4marks]**

QUESTION 6

(i) State any four applications of Bayes' rule in a digital communication system. **[4marks]**

(ii) Briefly explain three of the Digital modulation techniques and state three factors that can influence the choice of a digital modulation technique. **(4marks)**

(iii) The students' grades in a course are A, B, C, and D, and these are uniformly distributed among the students in the class. If the D grade is subdivided into three equal probable categories D^1, D^2, and D^3, calculate and compare the average information before and after subdividing the D grade. **[4marks]**

(iv)

QUESTION 7

(a) Draw a simplified block diagram of a PCM system. From the block diagram, describe the functions of each of the following parameters: (i) Low-pass filter at the transmitter end; (ii) Low-pass filter at the receiver end; and (iii) Repeaters. **[4marks]**

(b) As a communication engineer, state three ways by which you can mitigate the effects of channel-noise in a digital signal transmission. **[2marks]**

(c) Consider a channel having input and output characters x_1, x_2, and x_3 along with y_1, and y_2 respectively. The input probabilities are $P(x_1) = 1/20$, $P(x_2) = 1/2$ and $P(x_3) = 9/20$. Also the channel joint probability set P(XY) is given by:

$$[P(XY)] = \begin{bmatrix} \frac{1}{20} & 0 \\ \frac{1}{5} & \frac{3}{10} \\ \frac{1}{20} & \frac{2}{5} \end{bmatrix}$$

(i) Determine the channel conditional probability set [P(Y/X)] as well as the output probabilities and then make a sketch of the channel.

(ii) Find the values of the marginal entropies H(X) and H(Y),

(iii) Evaluate the joint entropy H(XY),

(iv) Evaluate the conditional entropies H(Y/X) and H(X/Y). **[6marks]**