CRAWFORD UNIVERSITY, FAITH CITY IGBESA
COLLEGE OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF COMPUTER AND MATHEMATICAL SCIENCES

SEMESTER: HARMATTAN **SESSION: 2022/2023**

COURSE CODE: ICT 319 **TITLE: COMMUNICATION AND INFORMATION THEORY**

UNITS: 3 **DURATION: 2.5 HOURS**

INSTRUCTION: ANSWER ANY FOUR QUESTIONS

QUESTION ONE (15 MARKS)

(A) Define the following:

i. Communication (2mrks)
ii. Information Theory (2mrks)
iii. Instantaneous Code (2mrks)
iv. S/N ratio (2mrks)

(B) Describe the basic principles of wave transmission (7mrks)

QUESTION TWO (15 MARKS)

(A) (i) Describe a general communication system. Explain the functions of each component (5mrks)

(ii) What is Self Information (I)? (2mrks)

(iii) Discuss the properties of Self Information (3mrks)

(B) (i) According to Shannon's Noisy-Channel Coding Theorem, under what conditions is error-free transmission possible? (2mrks)

(ii) Consider a pack of 32 playing cards, one of which is drawn at random. Calculate the amount of uncertainty of the event E = {the card drawn is the king of hearts}. Interpret the result. (3mrks)

QUESTION THREE (15 MARKS)

(A) (i) What is mutual information I(X,Y)? (3mrks)

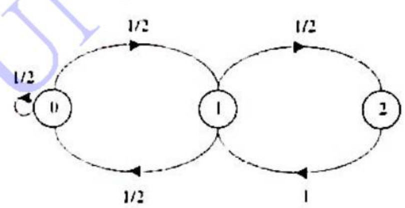
(ii) Identify the properties of mutual information (4mrks)

(iii) Describe with an illustrated diagram the relations between entropy, conditional entropy, joint entropy, and mutual information (3mrks)

(B) Describe waves and identify types based on propagation modes (5mrks)

QUESTION FOUR (15 MARKS)

(A) Given a Markov chain U taking on values in {0, 1, 2} whose transition graph is sketched below:



Derive the transition Matrix and obtain the entropy per symbol of source U, H, (U). (5mrks)

(B) (i) Consider C = {10,11,000,101,111,1100,1101}. Show that the code satisfies Kraft's inequality (2mrks)

(ii) Obtain the prefix code for C (in B (i)) above. (4mrks).

(iii) What is the chain rule for entropy? (2mrks)

(iv) Define Relative Entropy (2mrks)

QUESTION FIVE (15 MARKS)

(A) Let X and Y represent random variables with associated probability distributions p(x) and p(y), respectively. They are not independent. Their conditional probability distributions are p(x|y) and p(y|x), and their joint probability distribution is p(x, y).

(i) What is the entropy H(X) of variable X, and what is the mutual information of X with itself? (2mrk)

(ii) In terms of the probability distributions, what are the conditional entropies H(X|Y) and H(Y |X)? (2mrks)

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(iii) What is the joint entropy H(X,Y), and what would it be if the random variables X and Y were independent? (1mrk)

(iv) Give an alternative expression for H(Y) - H(Y|X) in terms of the joint entropy and both marginal entropies. (1mrk)

(v) What is the mutual information I(X;Y)? (1mrk)

(B) (i) What is Noise in communication? Discuss the types of Noise that can occur (4mrks)

(ii) Define the following, obtaining expressions where necessary:

- Noise Factor (2mrks)
- Entropy (H) (2mrks)

QUESTION SIX (15 MARKS)

(A) Given U as a memoryless source taking values in:

$\{A,B,C,D,E,F,G\}$, with the probabilities {0.4, 0.2, 0.15, 0.1, 0.05, 0.05, 0.05} respectively.

(i) What is the entropy of source U? (3mrks)

(ii) Show how the data can be compressed using both Shannon-Fano and Huffman algorithms. (5mrks)

(B) (i) Define the following Information Theory terminologies.

- 'Information' channel capacity (2mrks)
- 'Operational' channel capacity (2mrks)

(ii) Discuss the properties of Entropy in Information Theory (3mrks)

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