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

SEMESTER: HARMATTAN **SESSION: 2024/2025**

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. Entropy (H) **(2mrks)**

(B) (i) Discuss the properties of Entropy in Information Theory **(3mrks)**

(ii) Describe the basic principles of wave transmission **(6mrks)**

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) Let p(x, y) be given by:

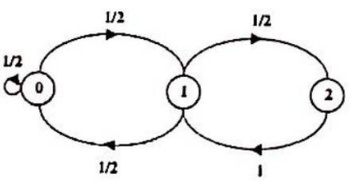
X \ Y	0	1
0	$\frac{1}{3}$	$\frac{1}{3}$
1	0	$\frac{1}{3}$

(i) H(X), H(Y) (ii) H(X|Y), H(Y|X) (iii) H(X;Y)

(iv) H(Y)-H(Y|X) (v) I(X;Y) **(5mrks)**

QUESTION FOUR (15 MARKS)

(A) (i) 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, $H_\infty(U)$. **(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) Considering a 27 symbol alphabet (26 letters and the space), Shannon studied different models of the English language. Discuss his simulations for an information source which delivers symbols or letters from this alphabet. **(7mrks)**

(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)**
- Antenna Gain **(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. **(8mrks)**

(B) Discuss Transmission impairments in communication **(4mrks)**