UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

FIRST SEMESTER EXAMINATIONS, NOV/DEC 2018

COURSE NO: CE 379

COURSE NAME: INFORMATION THEORY

CLASS: CE III **TIME:** 3 HOURS

Name: ____ Index Number: _______________

Answer ALL questions in Section A and any other TWO in Section B. Circle your answers in Section A.

SECTION A

1. Two cards are drawn at random from a pack of 52 cards. The probability that both are spades is
   a. 1/15
   b. 2/17
   c. 1/17
   d. 2/15
2. Following is not a unit of information
   a. Hz
   b. nat
   c. bit
   d. decit
3. The channel capacity of a noise free channel having M symbols is given by
   a. log M
   b. 2
   c. M
   d. None
4. Information content in a universally true event is
   a. Infinite
   b. Positive Constant
   c. Negative Constant
   d. Zero
5. As the bandwidth approaches infinity, the channel capacity becomes
   a. $1.44S/\eta$
   b. Infinite
   c. Zero
   d. None of the above
6. Entropy represents
   a. Information Signal
   b. Amplitude of Information
   c. Average Information per Message
   d. All of the above
7. The ideal communication channel is defined for a system which has
   a. finite C
   b. BW=0
   c. S/N = 0
   d. Infinite C
8. The channel capacity is a measure
   a. entropy rate
   b. maximum rate of information a channel can handle
   c. information contents of messages transmitted in a channel
   d. None of the above
9. The probability of a message is 1/16. The information in bits is
   a. 1 bit
   b. 2 bits
   c. 3 bits
   d. 4 bits

10.. Three light bulbs are chosen at random from 15 bulbs out of which 5 are defective. The probability that exactly one is defective

a. 24/91
b. 45/91
c. 67/91
d. None of the above

11. The probability density function of a Markov process is

a. p(x1,x2,x3.......xn) = p(x1)p(x2/x1)p(x3/x2).......p(xn/xn-1)
b. p(x1,x2,x3.......xn) = p(x1)p(x1/x2)p(x2/x3).......p(xn-1/xn)
c. p(x1,x2,x3......xn) = p(x1)p(x2)p(x3).......p(xn)
d. p(x1,x2,x3......xn) = p(x1)p(x2 * x1)p(x3 * x2)........p(xn * xn-1)

12. For M equally likely messages, the average amount of information H is

a. $H = \log_{10}M$
b. $H = \log_2 M$
c. $H = \log_{10}M^2$
d. $H = 2\log_{10}M$

13. Applications that require image compression include

a. Internet
b. Multimedia
c. Medical Imaging
d. All of the above

14. Information Rate

a. Information per Unit Time
b. Average Number of bits of Information Per Second
c. rH
d. All of the above

15. For M equally likely messages, M>>1, if the rate of information R ≤ C, the probability of error is

a. Arbitrarily small
b. Close to unity
c. Not predictable
d. Unknown

16. For a binary symmetric channel, the random bits are given as

a. Logic 1 given by probability P and logic 0 by (1-P)
b. Logic 1 given by probability 1-P and logic 0 by P
c. Logic 1 given by probability P2 and logic 0 by 1-P
d. Logic 1 given by probability P and logic 0 by $(1-P)^2$

17. The mutual information

a. Is symmetric
b. Always non negative
c. Both a and b are correct
d. None of the above

18. The relation between entropy and mutual information is

a. I(X;Y) = H(X) - H(X/Y)
b. I(X;Y) = H(X/Y) - H(Y/X)
c. I(X;Y) = H(X) - H(Y)
d. I(X;Y) = H(Y) - H(X)

19. The memory less source refers to

a. No previous information
b. No message storage
c. Emitted message is independent of previous message
d. None of the above

20. The information I contained in a message with probability of occurrence is given by (k is constant)
    a. I = k log21/P
    b. I = k log2P
    c. I = k log21/2P
    d. I = k log21/P2
21. When the base of the logarithm is 2, then the unit of measure of information is
    a. Bits
    b. Bytes
    c. Nats
    d. none of the above
22. The probability of a 4 turning up at least once in two tosses of a fair die is
    a. 11/36
    b. 17/36
    c. 13/36
    d. 19/36
23. The entropy for a fair coin toss is exactly
    a. 5 bits
    b. 3 bits
    c. 2 bits
    d. 1 bit
24. Huffman Code produces a code which uses a minimum number of bits to represent each symbol
    a. True
    b. False
25. For which value(s) of p is the binary entropy function H(p) maximized?
    a. 0
    b. 0.5
    c. 1
    d. 2
26. The more one learns, the more the uncertainty is
    a. True
    b. False
27. The followings are the applicable areas of Information Theory
    a. Data Compression
    b. Cryptography
    c. DSL Modem
    d. All of the above
28. The order of Commutation System is:
    Source to Encoder to Channel to Decoder to Destination
    a. True
    b. False
29. The major primary concern of Information Theory
    a. Source and Destination
    b. Channel
    c. Encoder and Decoder
    d. All of the above
30. The long quest of finding computationally-efficient codes include:
    a. Lossless Source Coding (Huffman Code)
    b. Noisy Channel Coding (Polar Code)
    c. Lossy Channel Coding (Polar Code)
    d. All of the above

SECTION B

1. Consider two random variables X1,X2 ∈ {0, 1} with joint p.m.f

(x1,x2)	(0, 0)	(0, 1)	(1, 0)	(1, 1)
p(x1,x2)	$\frac{1}{6}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{6}$

a. Compute H (X1), H (X2), and H (X1,X2)

b. Compute H (X1|X2 = 0), H (X1|X2 = 1), H (X1|X2), and H (X2|X1).

c. Compute I (X1; X2).

2 a. What do you understand by Self Information? Hence, state his properties

b. *A source puts out one of five possible messages during each message interval. The probability of these messages are {m_1,...,m_5} :P1=1/2, P2=1/4, P3=1/4, P4=1/16 and P5=1/16 What is the information content of these messages in bit?*

c. Define Entropy. What are its mathematical properties?

2 a. What do you understand by channel capacity? Describe the developmental process of data compression algorithms.

b. What are the application areas of Information Theory?

c. Consider the table below:

Symbol	**P(S)**
A	0.1
B	0.2
C	0.4
D	0.2
E	0.1

i. Compute Entropy (H)

ii. Build Huffman Code

iii. Compute Average Code Length

iv. Code “BCCADE”