



COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY  
SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

BACHELOR OF ENGINEERING PROGRAMME, YEAR 4 (BENG 4)

EEE 793 COMMUNICATION THEORY

**FINAL EXAMINATION**  
**(SEMESTER 1, 2017)**

**Duration – 3 Hour**

DATE/TIME/ROOM – Refer to Timetable

**INSTRUCTIONS TO CANDIDATES**

1. You are allowed 10 minutes extra time during which you are not to write.
2. Begin each answer on a fresh new page and use both sides of the sheets.
3. Write your identification number on the top of each attached sheet.
4. Insert all written foolscaps, graph paper, drawing paper etc. in their correct sequence and secure with string provided.
5. For all sheets of paper in which rough work has been done, cross it through and you must attach to your answer script.
6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.

SECTIONS	QUESTIONS	MARKS
A	6 Questions. Do any five	30
B	6 Questions. Do any five	50
C	2 Questions. All Compulsory	20
Total		100

Total no of pages – 5 (including cover page)

## SECTION A

Attempt any Five Questions

(5X6 = 30 Marks)

- (i) Define spread spectrum communication. What are the applications of spread spectrum modulation?
- (ii) What is the value of maximum signal to noise ratio of the matched filter? When it becomes maximum? On what factor, the error probability of matched filter depends.
- (iii) What is the necessity of adaptive equalization? Define the principle of adaptive equalization?
- (iv) Explain White Noise. Give the expression for equivalent noise temperature in terms of hypothetical temperature.
- (v) What is an eye pattern? Write the performance of data transmission system using eye pattern technique?
- (vi) In order to transmit an uncompressed video stream at 30 frames/second into a quarter size VGA window ( $160 * 120$  pixels), where each pixel requires 24bits for colour, what transmission capacity is required?

Given a link with a signal/noise ratio of 1023, what bandwidth is required to support the transmission rate from previous problem?

At the required bandwidth, how many bits will be transmitted per Hertz?

## SECTION B

Attempt Any Five Questions

(5X10 = 50 Marks)

### Question 1

Suppose that  $X$  is a random variable whose entropy  $H(X)$  is 8 bits. Suppose that  $Y(X)$  is a deterministic function that takes on a different value for each value of  $X$ .

- (i) What then is  $H(Y)$ , the entropy of  $Y$ ?
- (ii) What is  $H(Y|X)$ , the conditional entropy of  $Y$  given  $X$ ?
- (iii) What is  $H(X|Y)$ , the conditional entropy of  $X$  given  $Y$ ?
- (iv) What is  $H(X, Y)$ , the joint entropy of  $X$  and  $Y$ ?
- (v) Suppose now that the deterministic function  $Y(X)$  is not invertible; in other words, different values of  $X$  may correspond to the same value of  $Y(X)$ . In that case, what could you say about  $H(Y)$ ?

### Question 2

- (i) A source emits one of four possible symbols during each signaling interval. These symbols occur with the probabilities:  $P_0=0.4$ ,  $P_1=0.3$ ,  $P_2=0.2$  and  $P_3=0.1$ . Find the amount of information gained by observing the source emitting each of these symbols.

(ii) Define Sampling Theorem.

The human hearing system operates in the range of 2 – 20,000Hz. What sampling rate will be sufficient to preserve the information content of the signals in this range?

### Question 3

For a two stage amplifier, first amplifier has Voltage gain = 20, Input Resistance  $R_{in1}=700\Omega$ , equivalent Resistance  $R_{eq1}=1800\Omega$  and Output Resistor  $R_{o1}=30K\Omega$ . The corresponding values of second amplifier are: 25, 80 K $\Omega$ , 12 K $\Omega$ , and 1.2 M $\Omega$  respectively. What is the value of equivalent input noise resistance of the given two stage amplifier?

### Question 4

What is Inter-Symbol Interference (ISI) and its main cause? What are the techniques to Counter Inter symbol Interference?

### Question 5

A speech signal is sampled at a rate of 8 KHz, logarithmically compressed and encoded into a PCM format using 8 bits per sample. The PCM data is transmitted through an AWGN baseband channel via M-level PAM signaling. Calculate the required transmission bandwidth when (a)  $M = 4$ , (b)  $M = 8$  and (c)  $M = 16$ . (Assume rectangular pulses and the zero-to-null definition of bandwidth.)

### Question 6

What is the concept of Orthogonal Frequency Division Multiplexing? Give some advantages and disadvantages of OFDM.

**SECTION C**

**20 Marks**

- (i) Assume we wish to transmit a 56-kbps data stream using spread spectrum.
- (a) Find the channel bandwidth required to achieve a 56-kbps channel capacity when  $\text{SNR} = 0.1, 0.01, \text{ and } 0.001$ .
- (b) In an ordinary (not spread spectrum) system, a reasonable goal for bandwidth efficiency might be 1 bps/Hz. That is, to transmit a data stream of 56 kbps; a bandwidth of 56 kHz is used. In this case, what is the minimum SNR that can be endured for transmission without appreciable errors? Compare to the spread spectrum case.
- (ii) Draw the block diagram of Frequency-hopping spread spectrum Transmitter and Receiver.

What is the minimum number of bits in a PN sequence if we use FHSS with a channel bandwidth of  $B = 4 \text{ KHz}$  and  $B = 100 \text{ KHz}$ ?

**THE END**