THE PNG UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL & COMMUNICATIONS ENGINEERING DEPARTMENT

SECOND (2nd) SEMESTER (2023)

EE321- Communications Systems I

TIME ALLOWED: 3 HOURS

INFORMATION FOR STUDENTS:

1. You have **TEN (10) MINUTES to** read this paper. Do not write during this allocated time

2.There are **a total of FOUR (4) Questions** in this Exam Booklet. **Answer ALL QUESTIONS.**

3.All answers must be written in the **Answer Booklet. Total marks is 100.**

4.COMPLETE STUDENT DETAILS ARE TO BE FILLED ON THE ANSWER BOOKLET-DO THIS NOW

5.Drawing instruments and calculators are allowed on your desk. Textbooks and notebooks are **ALSO** allowed.

6.If you are found **Cheating** in this Exam, penalties specified by the **University** shall be applied.

7.TURN OFF all your mobile phones and place them on the floor under your seat before you start the examination

QUESTION 1

a) Determine the bit transmission rate in a pulse code modulation (PCM) system, if the numbers of quantization level are 16 and the maximum signal frequency is 4 KHz.

[4 marks]

b) In a 10-bit PCM system, a message signal having maximum frequency of 4 kHz is to be transmitted. If the bit rate of this PCM system is 60 $kbits/sec$, calculate the appropriate sampling frequency of this PCM system.

[4 marks]

c) For a Binary Frequency Shift Keying (BFSK) signal with a mark frequency of 49 kHz, a space frequency of 51 kHz, and an input bit rate of 2 kbps, calculate:

(i) the peak frequency deviation, **[2 marks]**
(ii) the minimum bandwidth, **[2 marks]**
(iii) the baud. **[2 marks]**

d) For a binary phase shift keying (BPSK) modulator with a carrier frequency of 70 MHz and an input bit rate of 10Mbps, calculate:

(i) the equation of this BPSK Output, **[2 marks]**
(ii) the maximum upper side frequency (USF), **[1 mark]**
(iii) the minimum lower side frequency (LSF), **[1 mark]**
(iv) the minimum Nyquist bandwidth, **[1 mark]**
(v) the baud. **[1 mark]**

e) Determine the maximum quantization error if an analog voltage residing in the range of 0 to 8 V is divided in eight equal intervals for conversion to 3-bit digital output.

[5 marks]

[TOTAL 25 Marks]

QUESTION 2

a) For the quadrature phase shift keying (QPSK) modulator shown in **Fig. Q2(a)** construct:

(i) The Truth Table, **[7 marks]**
(ii) Phasor Diagram, **[4 marks]**
(iii) Constellation Diagram. **[4 marks]**

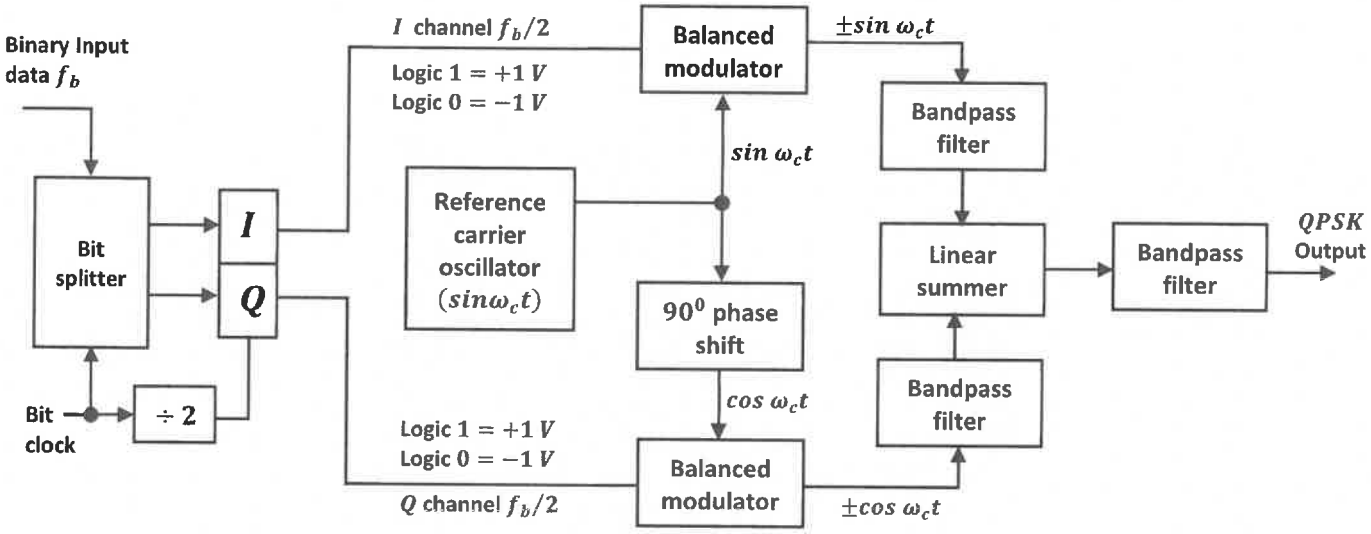

Fig. Q2(a)

b) Most practical communication systems consist of many stages. As a signal passes from one stage to another, it undergoes some change in signal level as well as other characteristics. **Fig. Q2(b)** shows an example of a tape cassette as it travels from playback head of the cassette unit to the antenna of the broadcast station. Analyze the output power value at the output of each component in the block diagram.

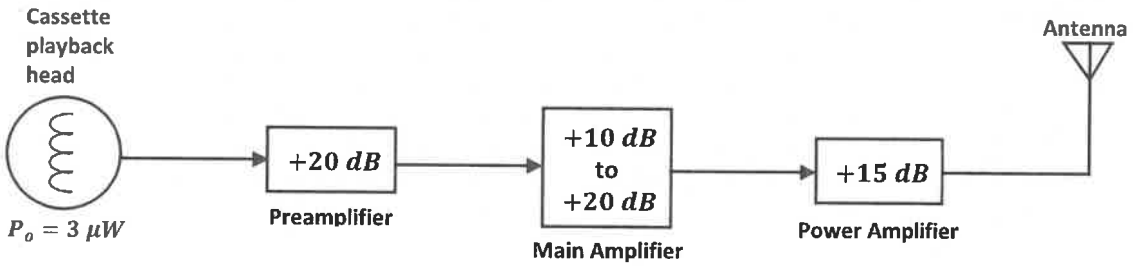

Fig. Q2(b)

[10 Marks]

TOTAL 25 Marks]

QUESTION 3

a) For a hamming code (HC) technique, determine:

(i) The number of errors that can be detected and corrected for data values with a hamming distance of FIVE. **[4 marks]**

(ii) The distance between the following two digital values: 110001010 and 010000010 **[2 marks]**

b) The **Fig. Q3(b)** presents a shift register of Cyclic Redundancy Check (CRC) code. For the data input bits **1011011** with the most significant bit (MSB) goes first into the register:

(i) Generate the CRC checksum. **[7 marks]**
(ii) Derive the data bits message to be received. **[3 marks]**

Hint: draw a table showing all the register contents.

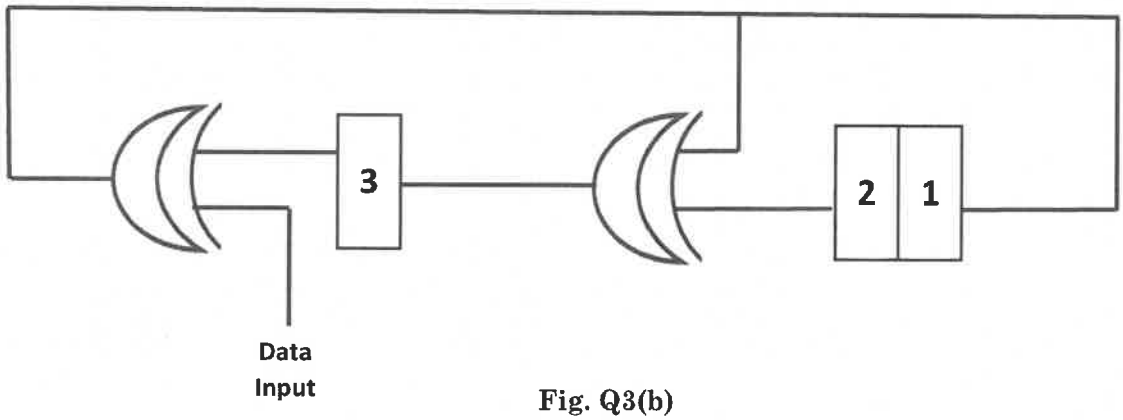

Fig. Q3(b)

c) For a (7,4) cyclic code, formed by a message polynomial $M(x) = 110011$ and a generator polynomial $g(x) = 11001$. Use Finite Algebra Theory to determine:

(i) The block check code/character (BCC). **[5 marks]**
(ii) The transmission codeword. **[4 marks]**

[TOTAL 25 Marks]

QUESTION 4

(a) An antenna with noise temperature of 75 K is connected to a receiver input with noise temperature of 300 K.

Calculate the overall:

(i) Noise Temperature. **[1 mark]**
(ii) Noise Ratio. **[1 mark]**
(iii) Noise Figure. **[1 mark]**

(b) The **Fig. Q4(b)** represents the first three stages of a typical AM or FM receiver.

Fig. Q4(b)

Find the following quantities:

(i) Total gain in absolute value, A_T and in decibel, $A_T(dB)$. **[2 marks]**
(ii) Gain (A_{P1}, A_{P2}, and A_{P3} in decibel) for each component. **[3 marks]**
(iii) Power at P_1, P_2, and P_{out} in Watts. **[3 marks]**
(iv) Power at P_{in}, P_1, P_2, and P_{out} in dBm. **[4 marks]**

Hint: Total gain (A) in cascade system is: $A = A_1 \times A_2 \times \cdots \times A_n$ with n, the number of cascaded components.

(c) A C-band earth station has an antenna with a transmit gain of 54 dB. The transmitter output power is set to 100 W at a frequency of 6.1 GHz. The signal is received by a satellite at a distance of 37,500 km by an antenna with a gain of 26 dB. The signal is then routed to a transponder with a noise temperature of 500 K, a bandwidth of 36 MHz, and a gain of 110 dB.

Calculate:

(i) The path loss at 6.1 GHz, if the wavelength is 0.04918 m. **[2 marks]**
(ii) The power, in dBW, at the output port of the satellite antenna. **[3 marks]**
(iii) The noise power, in dBW at the transponder input. **[3 marks]**
(iv) The carrier power, in dBW and in $watts$, at the transponder output. **[2 marks]**

[TOTAL 25 Marks]

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