UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2017/2018

COURSE NAME	:	DIGITAL COMMUNICATION
COURSE CODE	:	BEB 41803
PROGRAMME	:	BEJ
EXAMINATION DATE	:	DECEMBER 2017 / JANUARY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **NINE** (9) PAGES

ANSWER FIVE (5) QUESTIONS ONLY

Q1. (a) Describe the figure of merit for the performance of analog and digital communication systems.

(4 marks)

(b) From **Table Q1 (b)**, we see that the proposal from the Satellite Television Corporation called for a direct broadcast satellite (DBS) with an EIRP of 57 dBW and a downlink transmission frequency of 12.5 GHz. Assume that the only loss is the downlink space loss as shown. Suppose that the downlink information consists of a digital signal with a data rate of 5×10^7 bps. Assume that the required E_b/N_0 is 10 dB. The system temperature at your home receiver is 600 K, and that your rooftop dish has an efficiency of 0.55. What is the minimum dish diameter that you can use in order to close the link?

(6 marks)

(c) An eye pattern is the display that results from measuring a system's response to baseband signals in a prescribed way.

(i) State the information provided by an eye pattern.

(4 marks)

(ii) Illustrate the eye patterns of distorted polar non-return to zero (NRZ) waveform under ideal channel filtering and filtering that produces inter-symbol interference (ISI).

(6 marks)

Q2. (a) Consider a (6,3) systematic linear block code whose generator matrix is

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$$

(i) Construct all possible codewords.

(4 marks)

(ii) Suppose that the received codeword is 010111. Decode this received codeword by finding the location of the error and the transmitted data bits.

(4 marks)

(b) Design a Frequency Division Multiplexing (FDM) signal set consisting of five voice channels, each in the frequency range 300 to 3400 Hz. The multiplexed composite is to be made up of inverted sidebands and is to occupy the spectral region from 30 to 50 kHz.

(i) Sketch the composite spectrum, indicating individual spectrum and guard band frequency locations.

(5 marks)

(ii) Draw a block diagram showing the heterodyning and filtering details and the local oscillator values.

(7 marks)

Q3 (a) Differentiate the following levels of synchronization:

(i) Bit synchronization

(3 marks)

(ii) Symbol synchronization

(3 marks)

(iii) Frame synchronization

(3 marks)

(b) Spread-spectrum (SS) is a modulation technique where the occupied bandwidth of the transmitted signal is greater than that required by the underlying information bandwidth.

(i) List FOUR (4) beneficial attributes of spread-spectrum (SS) systems.

(4 marks)

(ii) With the aid of appropriate diagrams and mathematical expressions, discuss direct sequence spread-spectrum (DSSS) technique.

(7 marks)

Q4. (a) Consider a voice-grade telephone circuit with a bandwidth of 3 kHz. Assume that the circuit can be modelled as an adaptive white Gaussian noise (AWGN).

(i) What is the capacity of such a circuit if the signal-to-noise ratio (SNR) is 30 dB?

(2 marks)

(ii) What is the minimum SNR required for a data rate of 4800 bps on such a voice-grade circuit?

(2 marks)

(iii) Repeat **Q4 (a)(ii)** for a data rate of 19200 bps.

(2 marks)

(b) Explain how inter-symbol interference (ISI) occurs in a communication system and state a method that can be used to eliminate ISI.

(4 marks)

(c) Consider the convolutional encoder shown in **Figure Q4 (c)**.

(i) Write the polynomials for this encoder.

(2 marks)

(ii) Draw the state diagram.

(4 marks)

(iii) Draw the trellis diagram

(4 marks)

Q5. (a) The key to all multiplexing and multiple access schemes is that various signals share a communication resource without creating unmanageable interference to each other in the detection process.

(i) Explain the similarities and differences between the terms multiplexing and multiple access and give example for each scheme.

(4 marks)

(ii) Compare the distribution of communications resource in frequency division multiple access (FDMA), time division multiple access (TDMA) and code division multiple access (CDMA) using frequency-time plane illustration.

(6 marks)

(b) A transmitter has an output of 2W at a carrier frequency of 2 GHz. Assume that the transmitting and receiving antennas are parabolic dishes each 3 ft in diameter. Assume that the efficiency of each antenna is 0.55.

(i) Determine the gain of each antenna.

(3 marks)

(ii) Calculate the effective isotropic radiated power (EIRP) of the transmitted signal in units of dBW.

(2 marks)

(iii) If the receiving antenna is located 25 miles from the transmitting antenna over a free-space path, find the available signal power out of the receiving antenna in units of dBW.

(5 marks)

Q6. (a) Draw the transmitter and receiver of a frequency hopping spread-spectrum (FHSS) system.

(4 marks)

(b) By using a 7-bit data sequence, demonstrate how a pseudorandom (PN) bit stream encodes the data sequence in a direct sequence spread-spectrum (DSSS) transmitter. Next, show the decoding process at the system receiver.

(6 marks)

(c) Differentiate hard decision and soft decision.

(4 marks)

(d) The sequence of 1011011000101100 is the input to a 4×4 block interleaver. Demonstrate the interleaving procedure and determine the interleaver output. Next, show how the transmitted data being recovered at the receiver.

(6 marks)

- **END OF QUESTIONS** -

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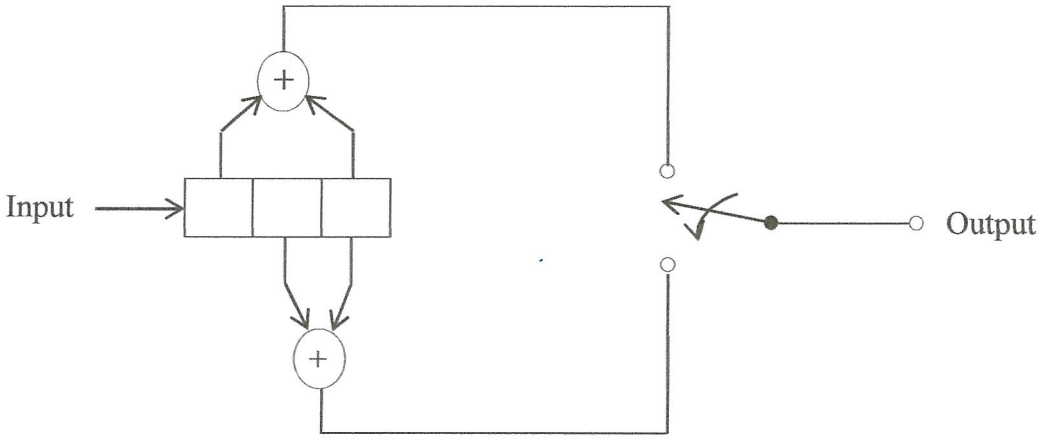

Figure Q4 (c)

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TABLE Q1 (b): Proposed Direct Broadcast Satellite (DBS) from Satellite Television Corp.

Uplink	
Earth station EIRP	86.6 dBW
Free-space loss (17.6 GHz, **48°** elevation)	208.9 dB
Assumed rain attenuation	12.0 dB
Satellite $\boldsymbol{G/T°}$	7.7 dB/K
Uplink $\boldsymbol{C/\kappa T°}$	102.0 dB-Hz

Downlink	Atmospheric Condition	
	Clear	5-dB Rain Attenuation
Satellite EIRP	57.0 dBW	57.0 dBW
Free-space loss (12.5 GHz, **30°** elevation)	206.1	206.1
Atmospheric attenuation	0.14 dB	5.0 dB
Home receiver $\boldsymbol{G/T°}$ (0.75 m dish)	9.4 dB/K	8.1 dB/K
Receiver pointing loss (0.5° error)	0.6 dB	0.6 dB
Polarization mismatch loss (average)	0.04 dB	0.04 dB
Downlink $\boldsymbol{C/\kappa T°}$	88.1 dB-Hz	82.0 dB-Hz
Overall $\boldsymbol{C/\kappa T°}$ (in 16 MHz)	87.9 dB-Hz	82.0 dB-Hz
Reference threshold $\boldsymbol{C/N}$	10.0 dB	10.0 dB
Margin over threshold	5.9 dB	0.0 dB