



INTI
International College Penang

FINAL
Examination Paper
(COVER PAGE)

Session : August 2018

Programme : Diploma in Electrical and Electronic Engineering (DEEI)

Course : EEE2111: Telecommunication Systems

Date of Examination : 11 December 2018 (Tuesday)

Time : 11:00am – 1:00pm

Duration : 2 Hours Reading Time : Nil

Special Instructions :

This paper consists of SIX (6) questions. Answer any FOUR (4) questions in the answer booklet provided. All questions carry equal marks.

IMPORTANT NOTE : THIS PAPER SHOULD NOT BE TAKEN OUT OF THE EXAMINATION HALL

Materials Permitted : Non Programmable Scientific Calculator

Materials Provided : Nil

Examiner(s) : Chong Kok Ming

Moderator : Prof. Ir. Dr. Mandeep Singh A/L Jit Singh

This paper consists of 7 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2111: TELECOMMUNICATION SYSTEMS
FINAL EXAMINATION: AUGUST 2018 SESSION

Instructions: This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Question 1

- a.) Draw an Amplitude Modulation (AM) diode envelope detector circuit and explain its functionality with the help of signal waveform at various points of the circuit. (5 marks)
- b.) State three (3) advantages and three (3) disadvantages of AM SSB-SC (Amplitude Modulation, Single Side Band Suppressed Carrier) compared to AM DSB (Amplitude Modulation Double Side Band). (5 marks)
- c.) An AM DSB signal is expressed as

$$V(t) = 300(1 + \sin 3000\pi t) \cdot \sin 3 \times 10^6 t \text{ (Volt)}$$

- i.) Write the equation in the terms of carrier frequency, lower sideband frequency and upper sideband frequency. (3 marks)
- ii.) Determine the modulation index, modulating frequency and carrier frequency. (3 marks)
- iii.) Draw the signal spectrum and label the amplitude and frequency accordingly. (3 marks)
- iv.) Calculate power of the signal when loaded on an antenna with 50Ω impedance. (2 marks)
- v.) AM DSB signal is converted to AM SSB-SC, calculate the power of the AM SSB-SC signal and the power saving percentage compare to AM DSB. (4 marks)

Question 2

- a.) Draw a block diagram of FM (Frequency Modulation) super heterodyne receiver and explain the functionality of each block in the diagram. (7 marks)
- b.) Explain the advantage of super heterodyne receiver concept compare to tuned radio frequency receiver. (3 marks)
- c.) Music signal for FM (Frequency Modulation) is band limited to 15 kHz and modulated on a carrier of 90 MHz with maximum deviation frequency of 75 kHz. Calculate the: -
- i.) Modulation index at maximum modulation frequency. (2 marks)
 - ii.) FM signal bandwidth using Bessel function and Carson's rules. (4 marks)
 - iii.) Image Frequency if the super heterodyne receiver has an IF (Intermediate Frequency) at 10.7 MHz. (3 marks)
- d.) Draw a block diagram showing how pre-emphasis and de-emphasis method is used to mitigate high frequency noise induced in FM transmission system. Explain the working principle with the help of frequency response diagram of audio signal. (6 marks)

Question 3

- a.) A stereo audio signal with amplitude of $1 V_{\text{rms}}$ maximum is PCM (Pulse Code Modulation) encoded using a 16 bits ADC at a sampling rate of 48 kHz. 8 bytes error correction code is added to the end of a set of 4 samples of stereo data. One complete data frame is formed by added 2 bytes header data in front of them. Calculate the:-
- i.) Maximum audio signal frequency permitted. (2 marks)
 - ii.) Resolution of PCM signal in mV. (2 marks)
 - iii.) Dynamic range (DR) in dB (2 marks)
 - iv.) Number of bits in one frame of data. (3 marks)
 - v.) Transmission speed of the channel to send these PCM data. (3 marks)
 - vi.) Draw data frame and clearly label the position of left and right audio data, error correction code and header data, and the number of bytes in it. (4 marks)

- b.) Given a message code (1 1 0 0) in encoded to be (7, 4) cyclic code with a generator polynomial $G(x) = x^3 + x + 1$.
- Calculate cyclic code generated. (3 marks)
 - Draw a sequential shift circuit for the given generator polynomial. (3 marks)
 - Draw the stage diagram for the given message code. (3 marks)

Question 4

- a.) A CCITT group channel consist of 12 channels AM SSB-SC (Amplitude Modulated Single Sideband Suppressed Carrier) telephony voice signal stacked together using FDM (Frequency Division Multiplexing) technique on a bandwidth of 48 kHz (60 – 108 kHz). Draw the signal spectrum of CCITT channel and mark the carrier frequency of each telephony voice channel in the band. (5 marks)
- b.) Explain functionality of delta modulation (DM) and draw a block diagram of the modulator. (5 marks)
- Draw a time waveform diagram to show delta modulation slope-overload distortion and granular noise. (3 marks)
- c.) 8 bits data 1-1-0-0-1-0-0-0 is encoded using Differential PSK (DPSK) technique.
- Draw block diagram of DPSK encoder (3 marks)
 - Use a table to calculate/generate the encoded DPSK data word. (5 marks)
 - Draw the timing waveform of the encoded DPSK signal, whereby $+\sin(\omega_c t)$ represent data bit 1, and $-\sin(\omega_c t)$ represent data bit 0. (4 marks)

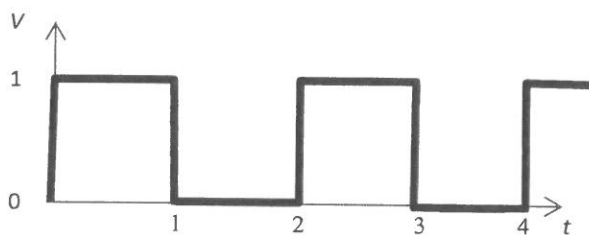
Question 5

- a.) Draw a diagram to show how skywave is used for long distance radio broadcasting. Illustrate in the diagram critical angle, skip zone, skip distance and groundwave coverage area (6 marks)
- b.) Given that Geostationary (GEO) orbit is at 35,863 km above earth surface. Calculate the:-
- Kepler's constant for earth. (3 marks)

- ii.) Orbiting period of a satellite orbiting in an orbit 1,500 km above earth surface. (2 marks)
- iii.) Number of satellites required in Medium Earth Orbit (MEO) at 10,000 km above earth surface to cover the earth surface 24 hours. (2 marks)
- c.) Ground station A transmits uplink frequency of 5.5 GHz to a satellite that is located at a distance of 40,000 km up in the sky. The satellite is equipped with an uplink receiver with 20 pW sensitivity and receiving antenna power gain of 100X. It is also equipped with a downlink transponder operating at frequency of 6 GHz, connecting to a transmitting antenna with power gain of 1,000X. Downlink receiving ground station B is located at a distance of 35,000 km from satellite. Station B is equipped with a receiving antenna with power gain of 10,000X and receiver with sensitivity is 20 pW.
- i.) Draw a diagram showing the communication link of A, B and satellite. (2 marks)
- ii.) Calculate the time delay of conversation between A and B. (2 marks)
- iii.) Calculate the transmitter antenna power gain required at station A if the station is transmitting power of 1 kW for uplink. (4 marks)
- iv.) Calculate the transmission power required for downlink transponder on the satellite. (4 marks)

Question 6

- a.) Time domain diagram of a periodic square wave signal $V(t)$ is shown as below, with period of 2 second



- i.) Write time domain equation of the signal (3 marks)
- ii.) Given Fourier series of the signal is $V(t) = a_0 + \sum_{n=1}^{\infty} a_n \sin(n\omega t)$, Calculate a_0 and a_n (3 marks)
- iii.) Write the signal equation in Fourier series till 5th harmonics. (3 marks)
- iv.) Draw the signal spectrum for fundamental frequency till 5th harmonics. Label each spectra frequency and amplitude accordingly (4 marks)

- b.) A and B are located at a distance of 20 km apart and setting up a telecommunication link using half wavelength dipole antenna and AM (Amplitude Modulation) technique with a carrier frequency of 50 MHz. The receiver sensitivity is 1 mV. Given half wavelength dipole antenna has an isotropic radiation pattern with power gain of 2.15 dB and impedance of 75Ω . Calculate the: -
- i.) Size of the dipole antenna. (2 marks)
 - ii.) Distance of far field radiation. (2 marks)
 - iii.) Field intensity at the receiving antenna (2 marks)
 - iv.) Minimum power required for transmission. (3 marks)
 - v.) Equivalent Isotropic Radiated Power (EIRP) of the antenna. (3 marks)

-- THE END --

Constant and Formulas

- 1.) Speed of light, $c = 3 \times 10^8$ m/sec; Earth's radius = 6371 km
- 2.) Fourier Series

$$f(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos(n\omega t) + \sum_{n=1}^{\infty} b_n \sin(n\omega t)$$

- $a_0 = \frac{1}{T} \int_{t_0}^{t_0+T} f(t) \cdot dt$
- $a_n = \frac{2}{T} \int_{t_0}^{t_0+T} f(t) \cos(n\omega t) \cdot dt \quad n = 1, 2, 3 \dots$
- $b_n = \frac{2}{T} \int_{t_0}^{t_0+T} f(t) \sin(n\omega t) \cdot dt \quad n = 1, 2, 3 \dots$

- 3.) Trigonometry identity: $\sin\alpha \cdot \sin\beta = \frac{1}{2} [\cos(\alpha - \beta) - \cos(\alpha + \beta)]$
- 4.) AM signal power $P_T = P_C \left(1 + \frac{m^2}{2}\right)$
- 5.) Kepler's Constant $K_S = \frac{T_a^2}{r_a^3} = \frac{T_b^2}{r_b^3}$
- 6.) Power received by antenna in free space, $P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi d)^2} W$
- 7.) Power equation for SATCOM link

$$\left(\frac{P_R}{P_T}\right)_{dB} \cong (G_T)_{dB} + (G_R)_{dB} - [32.5 + 20\log_{10}d + 20\log_{10}f] dB$$

Bessel Functions Table

Mod. index	Sideband amplitude														
	Carr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0.00	1.00														
0.25	0.98	0.12													
0.5	0.94	0.24	0.03												
1.0	0.77	0.44	0.11	0.02											
1.5	0.51	0.56	0.23	0.06	0.01										
2.0	0.22	0.58	0.35	0.13	0.03										
2.41	0.00	0.52	0.43	0.20	0.06	0.02									
2.5	-0.05	0.50	0.45	0.22	0.07	0.02	0.01								
3.0	-0.26	0.34	0.49	0.31	0.13	0.04	0.01								
4.0	-0.40	-0.07	0.36	0.43	0.28	0.13	0.05	0.02							
5.0	-0.18	-0.33	0.05	0.36	0.39	0.26	0.13	0.05	0.02						
5.53	0.00	-0.34	-0.13	0.25	0.40	0.32	0.19	0.09	0.03	0.01					
6.0	0.15	-0.28	-0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02					
7.0	0.30	0.00	-0.30	-0.17	0.16	0.35	0.34	0.23	0.13	0.06	0.02				
8.0	0.17	0.23	-0.11	-0.29	-0.10	0.19	0.34	0.32	0.22	0.13	0.06	0.03			
8.65	0.00	0.27	0.06	-0.24	-0.23	0.03	0.26	0.34	0.28	0.18	0.10	0.05	0.02		
9.0	-0.09	0.25	0.14	-0.18	-0.27	-0.06	0.20	0.33	0.31	0.21	0.12	0.06	0.03	0.01	
10.0	-0.25	0.04	0.25	0.06	-0.22	-0.23	-0.01	0.22	0.32	0.29	0.21	0.12	0.06	0.03	0.01

