INTI International College Penang

FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**April 2020**
Programme	:	Diploma in Electrical & Electronic Engineering (DEEI)
Course	:	**EEE2111: Telecommunication Systems**
Date of Examination	:	6 August 2020 (Thursday)
Time	:	8.00am – 11.00am Reading Time : Nil
Duration	:	3 Hours

Special Instructions :

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

Material permitted :
Non-Programmable Scientific Calculator

Materials provided :
Nil

Examiner(s)	:	**Mr Chong Kok Ming**
Chief Moderator	:	Dr. Solahuddin

*This paper consists of **6** printed pages, including the cover page*

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
EEE2111: TELECOMMUNICATION SYSTEMS
FINAL ALTERNATIVE ASSESSMENT: APRIL 2020 SESSION

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

Question 1

a.) A carrier signal of 1.1 MHz, 1.0 Volt peak is AM (Amplitude Modulation) modulated with a 1 kHz sine wave tone at modulation index of 50%.

i.) Draw the AM signal in time domain and label the amplitude of the carrier and envelope of the signal accordingly.

(3 marks)

ii.) Draw the AM signal spectra and label the frequency and amplitude of carrier, lower sideband and upper sideband accordingly.

(3 marks)

iii.) Given the frequency of the IF (Intermediate Frequency) is 455 kHz, draw the frequency spectrum at the output of mixer before IF filter.

(3 marks)

iv.) Calculate the image frequency seen by the receiver.

(2 marks)

v.) Draw the frequency response of a suitable band pass filter to produce AM SSB-SC (Single side band suppressed carrier) signal for modulation of voice signal of 3 kHz bandwidth. Label the center frequency and bandwidth of the band pass filter.

(3 marks)

vi.) Calculate the power of the SSB-SC signal when it is loaded on an antenna of 50 Ω impedance.

(2 marks)

vii.) Calculate the power saving of SSB-SC signal in this case compared to a transmission of whole AM-DSB (Amplitude Modulation – Double Sideband) with the same carrier and modulation index?

(3 marks)

b.) Draw the current flow direction of an AM-DBS balanced modulator in the following conditions:-

i.) Modulation input is zero, positive cycle of carrier.

(3 marks)

ii.) Positive modulation signal applied, positive cycle of carrier.

(3 marks)

Question 2

a.) Explain how super heterodyne receiver can overcome the limitations of tuned radio frequency receivers.

(4 marks)

b.) Draw a block diagram of Frequency Modulation (FM) super heterodyne receiver and explain the functionality of each block.

(7 marks)

c.) The FM transmitter is pre-emphasizing the audio signal at f_{3dB} = 2120 Hz.

i.) Draw a de-emphasis circuit with RC configuration that is suitable for reception sids. (2 marks)

ii.) Calculate an appropriate RC value fr the de-emphasis circuit.

(3 marks)

d.) An engineer tested an FM transmitter at 100 MHz using 3.4 kHz tone with the modulation index set at 5.

i.) Calculate the maximum frequency deviation and channel bandwidth of the system.

(4 marks)

ii.) Recommend a solution in order for this FM transmission to fit into the local telecommunication rules of 25 kHz channel bandwidth?

(5 marks)

Question 3

a.) An 8 bits binary word 1-0-0-1-1-1-0-0 is to be sent out using DPSK (Differential Phase Shift Keying) coding method.

i.) Use a table to calculate/generate the DPSK encoded data word.

(4 marks)

ii.) 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)

iii.) Use a table to show the DPSK decoding process to recover data from the signal sent out above.

(4 marks)

b.) What is the advantage and drawback of DPSK over PSK (Phase Shift Keying) modulation technique?

(4 marks)

c.) Given a message code (1 1 0 0) is encoded to be (7, 4) cyclic code with a generator polynomial $G(x) = x^3 + x + 1$.

i.) Calculate cyclic code generated.

(3 marks)

ii.) Draw a sequential shift circuit for the given generator polynomial.

(3 marks)

iii.) Draw the stage diagram for the given message code.

(3 marks)

Question 4

a.) A telecommunication link is set up with a transmission tower of height 120 m and the reception tower at 150 m height. Calculate the: -

i.) Line of Sight (LOS) distance

(2 marks)

ii.) Radio frequency Line of Sight distance.

(3 marks)

iii.) Explain the working principle that extends the transmission range from Line of Sight to Radio frequency Line of Sight.

(3 marks)

b.) Given that Geostationary (GEO) orbit is at 35,863 km above earth surface. Calculate the:-

i.) Kepler's constant for earth in unit min^2 / km^3.

(3 marks)

ii.) Orbiting period of a satellite orbiting in an obit 1,500 km above earth surface.

(3 marks)

iii.) Number of satellites required to put in Medium Earth Orbit (MEO) at 11,000 km above earth surface to cover the earth surface for 24 hours service.

(3 marks)

c.) A dipole antenna is operating at a frequency of 150 MHz.

i.) Calculate the far field distance of the antenna

(2 marks)

ii.) If a field intensity of 10 μV/m is detected by the antenna, calculate the voltage at the antenna terminal.

(2 marks)

iii.) Discuss a way to reduce the size of the dipole antenna by half, and calculate the reduced length antenna.

(2 marks)

iv.) Provide a way to improve directivity of the dipole antenna.

(2 marks)

– THE END –

Constants and Formulas

1.) Speed of light, c = $3 \times 10^8\ m/sec$

2.) Earth's radius = 6371 km

3.) Fourier Series

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

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

4.) Trigonometry identity

- $\sin\alpha \,.\, \sin\beta = \frac{1}{2}[\cos(\alpha-\beta) - \cos(\alpha+\beta)]$

5.) Mixer output with non-linear devices

$$f_{out} = |nf_c \pm mf_m| \quad where\ n,\ m\ are\ integers\ \ 0,\ 1, 2\ \ldots$$

6.) AM signal power $P_T = P_C(1 + \frac{m^2}{2})$

7.) Thermal noise power $P_n = kTB$, $k = Boltzmann's\ contant$ $(1.38 \times 10^{-23} J/K)$

8.) $LOS = 3.57\left(\sqrt{h_B} + \sqrt{h_L}\right)$, Radio $LOS = 4\left(\sqrt{h_B} + \sqrt{h_L}\right)$

9.) Kepler's Constant $K_s = \frac{T_a^2}{r_a^3} = \frac{T_b^2}{r_b^3}$

10.) Power equation for SATCOM link

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

11.) Far field distance $R > \frac{2D^2}{\lambda}$

12.) Parabolic Antenna $A_p \cong 6\left(\frac{D}{\lambda}\right)^2$, beamwidth $\cong \frac{70\lambda}{D}$

13.) Power received by antenna in free space, $P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi d)^2} W$

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