INTI International College Penang

FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**April 2021**
Programme	:	Diploma in Electrical & Electronic Engineering (DEEI)
Course	:	**EEE2111: Telecommunication Systems**
Date of Examination	:	27 July 2021 (Tuesday)
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. All questions carry equal marks.

Material permitted :
Non-Programmable Scientific Calculator

Materials provided :
Nil

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

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

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
EEE2111: TELECOMMUNICATION SYSTEMS
FINAL ALTERNATIVE ASSESSMENT: APRIL 2021 SESSION

Instructions: This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions. All questions carry equal marks.

Question 1

a.) Sketch the circuit diagram of an AM (Amplitude Modulation) demodulator using signal diode envelope detection method. Explain the function of the circuit with the aid of waveform diagram.

(6 marks)

b.) A 1 kHz sine wave tone with peak amplitude of 1.0 V is AM modulated on a radio carrier at frequency of 1.0 MHz and peak amplitude of 2.0 V. Determine the following: -

i.) Write the time equation of the AM signal.

(2 marks)

ii.) Sketch the time domain of the AM modulated signal. Label the amplitude of the waveform at maximum and minimum level accordingly.

(2 marks)

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

(2 marks)

iv.) A super heterodyne receiver with IF (Intermediate Frequency) at 455 kHz is used to receive the above signal. Sketch the frequency spectrum at the output of the mixer before the IF filter.

(3 marks)

v.) Find the frequency of the image channel. Comment what is the impact of reception in practical case for this particular image frequency.

(3 marks)

c.) An AM-DSB (Amplitude Modulation – Double Sideband) signal is modulated with a voice signal of bandwidth 300-3400 Hz. An AM SSB-SC (Single side band suppressed carrier) signal is generated using a band pass filtering method.

i.) Sketch the signal spectra of the AM DSB signal. On the spectrum diagram, sketch a suitable band pass filter response to produce the AM SSB-SC signal at the upper sideband. Label the center frequency and bandwidth of the band pass filter.

(2 marks)

ii.) Find the power saving of AM SSB-SC signal in this case compared to a transmission of the whole AM-DSB (Amplitude Modulation – Double Sideband) for maximum modulation index.

(2 marks)

iii.) Explain the disadvantage of the method used in Q1 c.) to generate AM SSB-SC signal. Give recommendation for a better solution to generate AM SSB-SC.

(3 marks)

Question 2

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

(6 marks)

b.) Explain two advantages and disadvantages of the super heterodyne receiver.

(4 marks)

c.) A 100 MHz carrier signal with amplitude of 100 Vp is frequency modulated (FM) with a 1 kHz sinewave signal with a maximum frequency deviation of 10 kHz.

i.) Write the time domain signal equation of the above FM signal.

(2 marks)

ii.) Find the FM signal bandwidth using Bessel function and Carson's rule.

(2 marks)

iii.) Explain what is the rationale behind the differences in bandwidth calculated using Bessel function and Carson's rule.

(2 marks)

iv.) Find the power radiated when the above FM signal is loaded on a 50 Ω antenna.

(2 marks)

d.) An engineer tested an FM transmitter at 100 MHz using 3 kHz tone with the modulation index set at 5.

i.) Find the maximum frequency deviation.

(2 marks)

ii.) Find the channel bandwidth using Bessel function table. (2 marks)

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

(3 marks)

Question 3

a.) A 10 bits PCM (Pulse-code modulation) encoder is used to sample a standard telephony signal that has a voltage swing of 0 ~ 1V peak. Find the: -

i.) Minimum sampling rate required

(2 marks)

ii.) The standard sampling rate is 8 kHz. Explain why it is different from the result calculated in Q3 a.) i.) above.

(2 marks)

iii.) Quantization resolution in mV

(2 marks)

iv.) Dynamic range in dB

(2 marks)

v.) Bandwidth required for PCM transmission

(2 marks)

vi.) Binary word coding for a signal amplitude of 220 mV

(2 marks)

b.) "0110 1100" data stream is modulated using QPSK (Quadrature Phase Shift Keying) technique. Given the Q/I mapping diagram for QPSK as shown in Figure 3b, sketch the QPSK time domain waveform.

(4 marks)

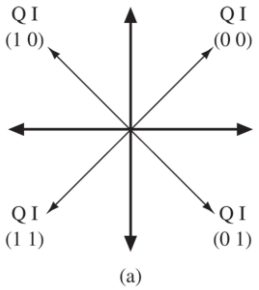

Figure 3b

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

i.) Find cyclic code generated.

(4 marks)

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

(2 marks)

iii.) Sketch the stage diagram for the sequential shift circuit in generating the given message code.

(3 marks)

Question 4

a.) A telecommunication link is set up with a transmission tower at a height of 120 m. The reception tower is located at 100 km away. The transmitter and receiver are operating at a frequency of 2.4 GHz and using same type of antenna with 30 dB gain.

i.) Find the height of the reception tower required to have proper communication between the 2 towers.

(2 marks)

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

(2 marks)

iii.) Find the transmitter power required to establish the communication if the receiver's sensitivity is 10 uW.

(3 marks)

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

i.) Explain the reason that GEO satellite is "stationary" above the ground.

(2 marks)

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

(3 marks)

iii.) Find the period of a satellite orbiting in an obit 1,500 km above earth surface.

(3 marks)

c.) A half wavelength dipole antenna which has an isotropic radiation pattern with power gain of 2.15 dB is transmitting 100W of signal power at 200 MHz TV signal. Another same type of dipole antenna is placed at a location 10 km away for reception.

i.) Find the size of the dipole antenna and distance where far field radiation is generated.

(2 marks)

ii.) Find the signal power received at the receiving antenna.

(3 marks)

iii.) Find the voltage level of the received antenna.

(2 marks)

iv.) Sketch the dipole antenna radiation pattern in 2D and 3D view.

(3 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.) Integration by parts: $\int u\ dv = u.v - \int v\ du$

6.) Mixer output with non-linear devices

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

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

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

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

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

11.) Power equation for SATCOM link

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

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

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

14.) 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