FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**April 2022**
Programme	:	Diploma in Electrical and Electronic Engineering (DEEI)
Course	:	EEE2111: Telecommunications Systems
Date of Examination	:	04 August 2022(Thursday)
Time	:	08.00am-11.00am Reading Time : Nil
Duration	:	3 Hours

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer **ALL** questions.

Material permitted : Non-Programmable Scientific Calculator

Materials provided : Nil

Examiner(s)	:	Dr. Solahuddin Yusuf Fadhlullah
Chief Moderator	:	Alan Wong

This paper consists of 9 printed pages, including the cover page

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
EEE2111: TELECOMMUNICATION SYSTEMS
FINAL ALTERNATIVE ASSESSMENT: APRIL 2022 SESSION

Instructions: This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions. 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) Write the AM signal equation in the terms of carrier frequency, lower sideband frequency and upper sideband frequency.

(3 marks)

(ii) Sketch the AM signal in time domain and label the amplitude of the carrier and envelope of the signal accordingly.

(2 marks)

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

(2 marks)

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

(4 marks)

(v) Calculate the image frequency seen by the receiver when tuned to the 1.1 MHz carrier frequency.

(2 marks)

(b) An FM (Frequency Modulation) signal is expressed as:

$$V(t)=100 \sin (\pi\times10^{8}\, t + 3 \sin 6\times10^{4}\, t) \text{ Volt.}$$

Calculate the:

(i) Modulating frequency

(2 marks)

(ii) Carrier frequency

(2 marks)

(iii) Maximum frequency deviation.

(2 marks)

(iv) FM signal bandwidth using Bessel function

(2 marks)

(v) FM signal bandwidth using Carson's rules

(2 marks)

(vi) Signal power with load impedance of 50 Ω.

(2 marks)

Question 2

(c) A voice signal with frequency range of 300 Hz to 3.4 kHz has a maximum signal level of 1.0 V is encoded with PCM (Pulse Code Modulation) using an 8 bits words. Calculate the:

(i) Minimum sampling rate.

(2 marks)

(ii) Quantization resolution in mV.

(2 marks)

(iii) Dynamic range in dB.

(2 marks)

(iv) Bandwidth required for transmission.

(2 marks)

(v) Binary word coding for an input signal of 380 mV.

(2 marks)

(vi) Quantization error at 380 mV.

(2 marks)

(d) By using an illustration, explain the problem of aliasing in sampling.

(3 marks)

(e) A (7,3) cyclic code has a generator word of 10111. The message code is given as (101). Determine:

(i) The cyclic code generated.

(4 marks)

(ii) Whether any errors have occurred if the received word is 1110101.

(2 marks)

(f) Constellation diagram provides the phase and magnitude information for a modulation system. Explain two other importance of the constellation diagram.

(4 marks)

Question 3

(a) Figure Q3a shows a modulated signal over a period of 1 second.

(i.) Draw the constellation diagram for the signal.

(2 marks)

(ii.) Identify the modulation technique of the signal.

(1 mark)

(iii.) Determine the bit rate of the signal.

(1 mark)

(iv.) Determine the symbol rate of the signal.

(1 mark)

(v.) Sketch the spectrum of the signal in frequency domain.

(2 marks)

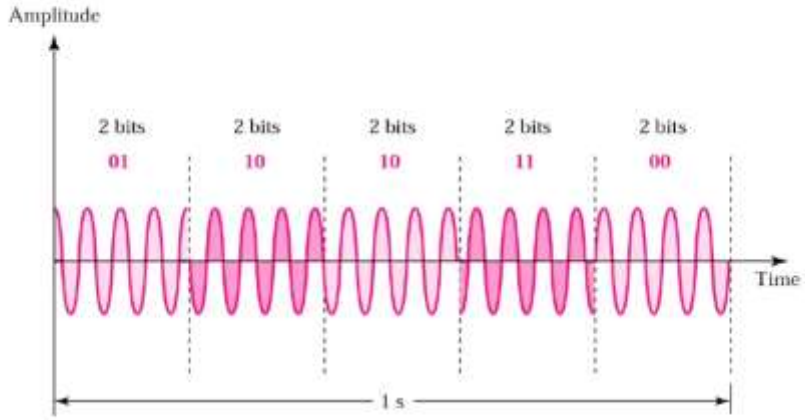

Figure Q3a

(b) Figure Q3b shows a Global System for Mobile Communications (GSM) signal with carrier frequency and Time-Division Multiple Access (TDMA) frame structure. Calculate:

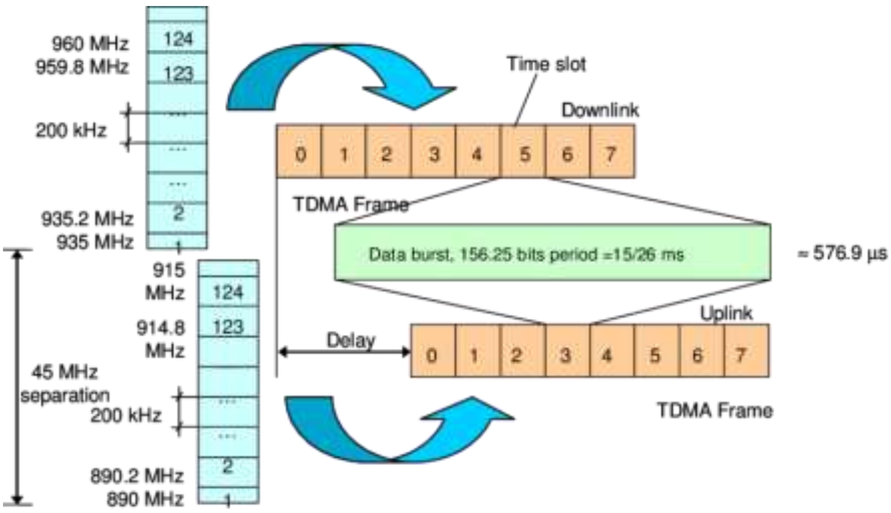

Figure Q3b

(i) The bandwidth for each GSM frequency band.

(2 marks)

(ii) The number of RF carriers (channels) for any one of the GSM frequency band.

(1 mark)

(iii) The bit rate of each time slot.

(2 marks)

(iv) Explain the function of a guard band in a GSM frame.

(1 mark)

(c) 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 generate the DPSK encoded data word.

(3 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.

(1 mark)

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

(2 marks)

(d) Explain the negative effect of the following factors on wave propagation:

(i) Shadowing

(2 marks)

(ii) Scattering

(2 marks)

(iii) Multipath

(2 marks)

Question 4

(a) Explain a difference and a similarity between multiple access and multiplexing.

(4 marks)

(b) A line-of-sight (LOS) ground wave telecommunication link is set up between 2 towers; Tower A and B. Tower A has a height of 120 m and Tower B is located 100 km away from Tower A. The link is operating at a frequency of 2.4 GHz and using same type of antenna with 30 dB gain.

(i) Determine the height of Tower B in direct LOS telecommunication.

(2 marks)

(ii) Calculate the transmitter power required to establish the communication if the receiver's sensitivity is 10 μW.

(2 marks)

(iii) Explain why 2.4 GHz frequency is not suitable for ground wave telecommunication.

(2 marks)

(c) A satellite is orbiting at a distance of 900 km above the Earth's surface.

(i) Calculate the orbital period of the satellite. Use the relevant formulas provided in the Appendix section.

(3 marks)

(ii) Explain two operational characteristics of the type of satellite identified in part i.).

(4 marks)

(d) A half wavelength dipole antenna with power gain of 2.15 dB is radiating a signal of 200 MHz at power level of 100 W. Another same type of half wavelength dipole antenna is placed at a location 10 km away for reception. Calculate the:

(i) Size of the dipole antenna.

(2 marks)

(ii) Distance where far field radiation is detected.

(2 marks)

(iii) Signal power received at the receiving antenna.

(2 marks)

(iv) Voltage level at the receiving antenna terminal, given that the dipole antenna impedance is 73Ω.

(2 marks)

– THE END –

Appendix: Constants and Formulas

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

2.) Earth's radius = 6371 km

3.) Fourier Series

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

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

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

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, $P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi d)^2} W$

15.) h = orbital altitude from Earth's surface

$$flight\ velocity:\ v = \sqrt{\frac{398600.5}{6378.14+h}} \quad (km/s)$$

$$orbital\ period:\ P = 2\pi\frac{6378.14+h}{v} \quad (sec)$$

Bessel Function Table

Bessel Functions $J_n(\beta)$ shown to 4 decimal places.

β	$J_0(\beta)$	$J_1(\beta)$	$J_2(\beta)$	$J_3(\beta)$	$J_4(\beta)$	$J_5(\beta)$	$J_6(\beta)$	$J_7(\beta)$	$J_8(\beta)$	$J_9(\beta)$	$J_{10}(\beta)$	
0.1	0.9975	0.0499	0.0012									
0.2	0.9900	0.0995	0.0050	0.0002								
0.4	0.9604	0.1960	0.0197	0.0013	0.0001							
0.6	0.9120	0.2867	0.0437	0.0044	0.0003							
1.0	0.7652	0.4401	0.1149	0.0196	0.0025	0.0002						
1.5	0.5118	0.5579	0.2321	0.0610	0.0118	0.0018	0.0002					
2.0	0.2239	0.5767	0.3528	0.1289	0.0340	0.0070	0.0012	0.0002				
3.0	-0.2601	0.3391	0.4861	0.3091	0.1320	0.0430	0.0114	0.0025	0.0005	0.0001		
4.0	-0.3971	-0.0660	0.3641	0.4302	0.2811	0.1321	0.0491	0.0152	0.0040	0.0009	0.0002	
5.0	-0.1776	-0.3276	0.0466	0.3648	0.3912	0.2611	0.1310	0.0534	0.0184	0.0055	0.0015	
6.0	0.1506	-0.2767	-0.2429	0.1148	0.3576	0.3621	0.2458	0.1296	0.0565	0.0212	0.0070	
7.0	0.3001	-0.0047	-0.3014	-0.1676	0.1578	0.3479	0.3392	0.2336	0.1280	0.0589	0.0235	
8.0	0.1717	0.2346	-0.1130	-0.2911	-0.1054	0.1858	0.3376	0.3206	0.2235	0.1263	0.0608	
9.0	-0.0903	0.2453	0.1448	-0.1809	-0.2655	-0.0550	0.2043	0.3275	0.3051	0.2149	0.1247	
10.0	-0.2459	0.0435	0.2546	0.0584	-0.2196	-0.2341	-0.0145	0.2167	0.3179	0.2919	0.2075	