INTI International College Penang

FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**January 2022**
Programme	:	Diploma in Electrical & Electronic Engineering (DEEI)
Course	:	**EEE2111: Telecommunication Systems**
Date of Examination	:	10 March 2022 (Thursday)
Time	:	2.00pm – 5.00pm 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)	:	**Dr. Solahuddin**
Chief Moderator	:	Chong Kok Ming

*This paper consists of **8** printed pages, including the cover page*

INTI INTERNATIONAL COLLEGE PENANG

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

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

Question 1

a.) Define the following terms in wireless transmission:

i.) Antenna Bandwidth.

(2 marks)

ii.) Equalizers.

(2 marks)

iii.) Inter-symbol interference (ISI).

(2 marks)

iv.) Aperiodic signal.

(2 marks)

v.) Periodic Signals.

(2 marks)

b.) An FM signal expressed as $V(t) = 50Cos(2\pi 10^7 t + 0.4Cos2\pi 10^4 t)$ is measured across a 50 Ω antenna. Determine the following:

i.) Total antenna power.

(2 marks)

ii.) Modulation Index.

(2 marks)

iii.) Peak frequency deviation.

(2 marks)

iv.) Bandwidth based on Carson's rule.

(2 marks)

v.) Power of the first sideband at the antenna.

(2 marks)

vi.) Sum of all sidebands power at the antenna.

(3 marks)

vii.) Comparing FM signal with modulation index less than 0.5 with DSB-AM signal, which signal will need less power for good quality atmospheric transmission. Give reason for your answer.

(2 mark)

Question 2

a.) 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)

b.) Explain why Nyquist theorem must be obeyed during the sampling process. Sketch an illustration to prove your point.

(4 marks)

c.) A (7,4) cylic code has a generator polynomial of $G(x) = x^3 + x + 1$. The message code is given as (1101).

i.) Determine the cyclic code generated.

(3 marks)

ii.) Determine, with proof, whether (1000000) is a valid generated cyclic code.

(2 marks)

d.) 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)

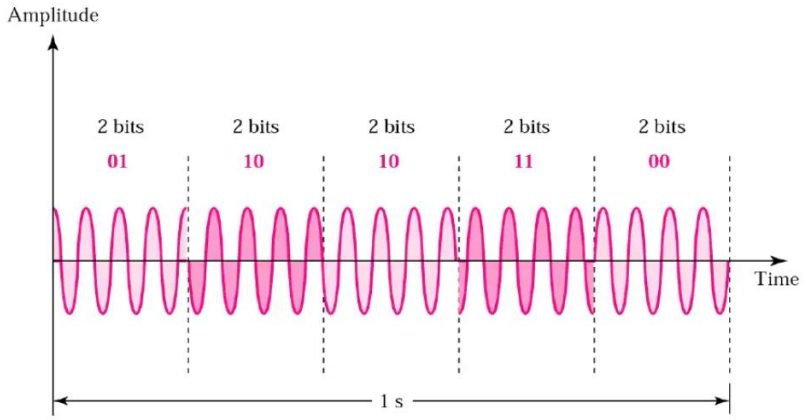

Figure Q3a

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

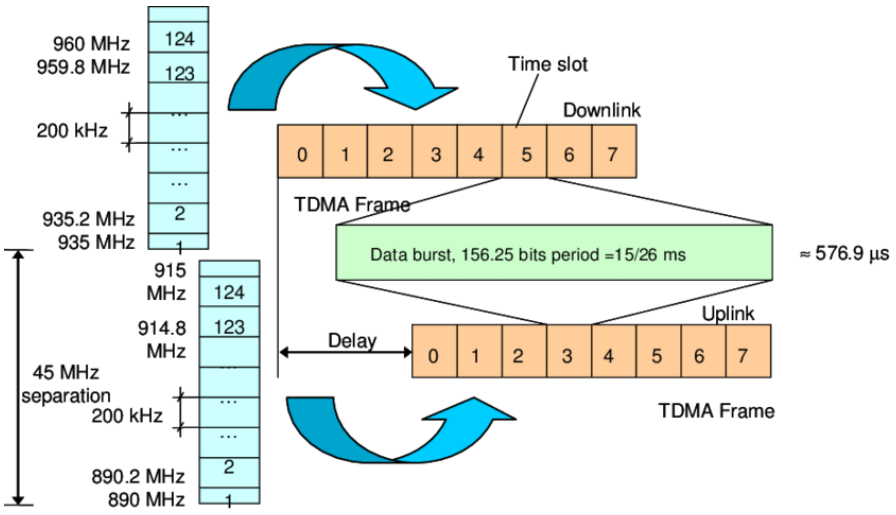

Figure Q3b

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.) Discuss three problems associated with skywave propagation in a telecommunication system.

(6 marks)

Question 4

a.) By using an illustration, explain how orthogonality improves the signal quality in a multiple access network.

(3 marks)

b.) A line-of-sight (LOS) ground wave telecommunication link is set up between 2 towers. Tower A has a height of 40 m and Tower B is located 50 km away from Tower A.

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

(2 marks)

ii.) Calculate the maximum Radio Frequency LOS distance if Tower B is 55 m in height.

(2 marks)

iii.) Explain why ground wave telecommunication is suitable for frequencies below 2 MHz.

(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 150 MHz at power level of 100W. 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 75 Ω.

(3 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

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

- $a_0 = \frac{1}{T}\int_{t_0}^{t_0+T} f(t) \cdot dt$
- $a_n = \frac{2}{T}\int_{t_0}^{t_0+T} f(t)\cos(n\omega t) \cdot dt$ *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, $P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi d)^2} W$

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

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

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

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	