INTI
International College Penang

FINAL
Examination Paper

(COVER PAGE)

Session	:	**April 2019**
Programme	:	Diploma in Electrical and Electronic Engineering (DEEI)
Course	:	**EEE2111: Telecommunication Systems**
Date of Examination	:	1 August 2019 (Thursday)
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 8 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2111: TELECOMMUNICATION SYSTEMS
FINAL EXAMINATION: APRIL 2019 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.) A carrier signal at 1.200 MHz and amplitude 10 V*p* is AM (Amplitude Modulation) modulated with a 1000 Hz sine wave at 30% modulation index.

i.) Write the AM signal time domain equation in the terms of carrier frequency, lower sideband frequency and upper sideband frequency. (3 marks)

ii.) Draw the AM signal spectrum and label its amplitude and frequency accordingly. (3 marks)

iii.) Calculate power of the signal loaded on an antenna with 50 Ω impedance. (2 marks)

b.) Draw the block diagram of AM Super Heterodyne Receiver and explain the function of each functional block. (8 marks)

c.) A Super Heterodyne Receiver with IF (Intermediate Frequency) of 455 kHz is tuned to a carrier frequency at 1.200 MHz. Calculate the: -

i.) Receiver's local oscillator frequency. (2 marks)

ii.) Frequency of image station. (2 marks)

iii.) Frequency of all signal components produced by the mixer, including second harmonics. (5 marks)

Question 2

a.) An amplifier with voltage gain of 200 has an operating frequency bandwidth of 2 MHz Its input resistance is 1 kΩ and is operating at temperature 27 °C. An impedance matched input signal of 20 μV is applied. Calculate the: -

i.) Thermal noise power at input.

(2 marks)

ii.) SNR (Signal-to-Noise Ratio) at input.

(2 marks)

iii.) NF (Noise Figure) of the amplifier given the output SNR is 8.

(2 marks)

b.) An FM (frequency modulation) signal, $10\sin(6\times10^8 + 2\sin(\pi\times10^4 t))\,t$, is applied to an antenna with 50 Ω impedance. Determine the: -

i.) Carrier frequency.

(2 marks)

ii.) Modulation frequency (f_m) and modulation index (m_f).

(3 marks)

iii.) Maximum frequency deviation.

(2 marks)

iv.) FM signal bandwidth using Bessel function and Carson's rule.

(4 marks)

v.) Total transmitted signal power.

(2 marks)

c.) 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.) An 8 bits PCM (Pulse-code modulation) encoder is used to sample a standard telephony signal with frequency range 300 Hz to 3.4 kHz that has a voltage swing of 0 ~ 1V peak. Calculate the: -

i.) Minimum sampling rate required

(2 marks)

ii.) Quantization resolution in mV

(2 marks)

iii.) Dynamic range in dB

(2 marks)

iv.) Bandwidth required for PCM signal transmission

(2 marks)

v.) Binary word coding for an input signal of +600 mV and its quantization error

(4 marks)

b.) PCM method causes signal quantization error. What are the two methods used to improve accuracy of signal digitization? What is the drawback of these methods?

(4 marks)

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

i.) Calculate cyclic code generated using conventional division method.

(3 marks)

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

(3 marks)

iii.) Draw the stage diagram of the sequential shift circuit generating the cyclic code with the given message code.

(3 marks)

Question 4

a.) Draw BPSK (Binary Phase Shift Keying) receiver block diagram and explain how it works.

(5 marks)

b.) BPSK stage "1" is modulated as $\sin(\omega_c t)$ signal and stage "0" as $-\sin(\omega_c t)$.

i.) Show mathematical derivation that stage "1" is output as positive DC value, and stage "0" is output as negative DC value.

(6 marks)

ii.) A 8 bits data stream "1101 1000" is modulated using BPSK technique. Draw the digital base band time signal waveform and the corresponding BPSK waveform diagram. Label $\sin(\omega_c t)$ and $-\sin(\omega_c t)$ on the diagram accordingly.

(6 marks)

c.) Draw a block diagram of delta modulation (DM) modulator and explain how it works.

(5 marks)

d.) Draw a time waveform diagram to show delta modulation slope-overload distortion and granular noise.

(3 marks)

Question 5

a.) Define the following terms and give example of waveform diagram for each one

i.) Periodic signal

(2 marks)

ii.) Deterministic signal

(2 marks)

iii.) Random signal

(2 marks)

iv.) Even symmetry signal

(2 marks)

b.) A communication satellite is located on an orbit that is 40,000 km above ground. A person using a satellite phone is standing at a location of 48,000 km away from the satellite. This satellite is transmitting 4.5 GHz signal at 1.5 kW signal power with an antenna of 40,000X power gain. The receiver has a receiving antenna with 25X power gain. Calculate

i.) Signal delay time the person has with ground station.

(2 marks)

ii.) Power of signal received by the satellite phone.

(6 marks)

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

i.) Kepler's constant for earth in unit hour^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 in Medium Earth Orbit (MEO) at 10,000 km above earth surface to cover the earth surface 24 hours.

(3 marks)

Question 6

a.) Explain the meaning of isotropic radiation pattern

(3 marks)

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

i.) Size of the dipole antenna.

(2 marks)

ii.) Distance where far field is detected.

(2 marks)

iii.) Signal power received at the receiving antenna.

(3 marks)

iv.) Voltage level of the received antenna.

(3 marks)

v.) Draw the dipole antenna radiation pattern in 2D and 3D view.

(3 marks)

c.) Discuss how can you: -

i.) Reduce the size of the dipole antenna by half.

(2 marks)

ii.) Improve directivity of the dipole antenna.

(2 marks)

iii.) Calculate the diameter of parabolic reflector required to send a signal at 10 GHz with a beaming of 3°.

(2 marks)

iv.) What is the power gain of this parabolic antenna in dB?

(3 marks)

– THE END –

Constant and Formulas

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

2.) Earth's radius = 6371 km

3.) Fourier Series

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

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

4.) Trigonometry identity

- $sin\alpha . sin\beta = \frac{1}{2}[\cos(\alpha - \beta) - \cos(\alpha + \beta)]$
- $\sin^2 \alpha = \frac{1}{2}[1 - cos2\alpha]$

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.) Signal-to-noise ratio SNR = $\frac{P_s}{P_n}$

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

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

11.) Power equation for SATCOM link

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

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