INTI
International College Penang

FINAL
Examination Paper

(COVER PAGE)

Session	:	**April 2018**
Programme	:	Diploma in Electrical and Electronic Engineering (DEEI)
Course	:	**EEE2111: Telecommunication Systems**
Date of Examination	:	30 July 2018 (Monday)
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 :
Graph Paper

Examiner(s)	:	**Chong Kok Ming**
Moderator	:	Prof. Ir. Dr. Mandeep Singh Jit Singh

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

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2111: TELECOMMUNICATION SYSTEMS
FINAL EXAMINATION: APRIL 2018 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.) Draw block diagram of AM (Amplitude Modulation) Super Heterodyne Receiver and explain the function of each functional block.

(6 marks)

b.) 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 all signal components at IF mixer output signal

(5 marks)

c.) An audio signal of 300 Hz to 3 kHz is AM modulated on a carrier signal of 1.2 MHz, Vp = 1.0 V at modulation index of 50%.

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

(4 marks)

ii.) Draw the response of a suitable band pass filter to produce AM SSB-SC (Amplitude modulation – single side band suppressed carrier) signal from this spectra with label of center frequency and bandwidth of band pass filter.

(3 marks)

iii.) Calculate power of the SSB-SC (Single Sideband – Suppressed Carrier) signal when it is loaded on an antenna with 50 Ω impedance.

(2 marks)

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

(3 marks)

Question 2

a.) Explain what is external noise and internal noise that appear to a receiver. Give two (2) examples of noise source for each of these noises.

(4 marks)

b.) A receiver with antenna captured a signal of 1 μV with noise 0.2 μV, produces an output of 100 mV signal with noise 5 mV. Calculate the: -

i.) Input SNR (Signal-to-Noise Ratio)

(2 marks)

ii.) Output SNR (Signal-to-Noise Ratio)

(2 marks)

iii.) Noise figure (NF) of the receiver

(2 marks)

c.) Give a FM (Frequency Modulation) signal equation is

$$V(t) = 100\sin(\pi \times 10^8 t + 2\, sin2\pi \times 10^4 t)\ \text{Volt.}$$

Calculate the: -

i.) Modulating frequency and carrier frequency

(2 marks)

ii.) Modulation index and maximum frequency deviation.

(2 marks)

iii.) FM signal bandwidth using Bessel function and Carson's rules?

(4 marks)

iv.) Signal power with load impedance of 50Ω.

(2 marks)

d.) 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 of audio signal.

(5 marks)

Question 3

a.) Draw a PCM (Pulse Code Modulation) encoding system block diagram. Explain functionality of sample-and-hold and analog to digital converter.

(10 marks)

b.) If a sine wave signal is sampled at 10 times of its frequency and digitized into 10 quantum steps in full voltage range. Draw a time signal diagram of 1 cycle with : -

i.) Output signal waveform at Sample-and-hold (S/H)

(3 marks)

ii.) Quantization error of the digitized signal

(3 marks)

iii.) Draw a 4 bits binary weighted resistor DAC (Digital to analog converter) circuit using resistors network and operational amplifier. Write the equation of DAC output V_o in terms of V_{Ref}, R_f, R and b_n

(4 marks)

c.) Give two (2) advantages and two (2) disadvantage of binary weighted resistor ADC circuit?

(5 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.

(5 marks)

ii.) A 4 bits data stream "1101" 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.

(5 marks)

c.) i.) Explain how QPSK (Quadrature Phase Shift Keying) modulation technique can increase transmission bandwidth efficiency by factor of two (2) compare to BPSK technique.

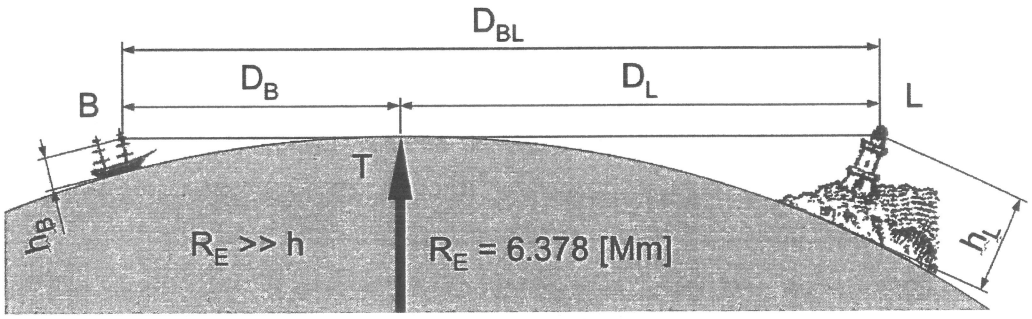
(5 marks)

ii.) Draw block diagram of a QPSK system using 2 BPSK that is orthogonally shifted for detection.

(5 marks)

Question 5

a.) Refer to the diagram below, where R_E is earth radius.



i.) Proof that distance $D_B = \sqrt{h_B^2 + 2R_E h_B}$

(4 marks)

ii.) Calculate that Line of Sight (LOS) distance is

$$D_{BL}[km] = 3.57(\sqrt{h_B} + \sqrt{h_L})$$

where h_B and h_L are height in meter and $<< R_E$

(6 marks)

b.) A telecommunication link is setup with transmission tower at height of 120 m and reception tower at 200 m height. Calculate the: -

i.) Line of Sight (LOS) distance

(2.5 marks)

ii.) Radio frequency Line of Sight distance.

(2.5 marks)

c.) P and Q is having a tele-conversation via a satellite link. Distance between P and satellite is 40,000 km, and Q is 35,000 km. The satellite downlink frequency is 5.5 GHz, and the antenna power gain is 30,000X. Calculate the: -

i.) Time delay of conversation between P and Q

(5 marks)

ii.) Power received by P, if satellite transmitter is 1 kW and the receiver antenna power gain is 50X

(5 marks)

Question 6

a.) Draw a diagram showing how voltage and current varies along a half-wavelength dipole antenna. (3 marks)

b.) A dipole antenna operating at frequency of 150 MHz.

i.) Calculate the far field distance of the antenna

(3 marks)

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

(3 marks)

c.) Explain with help of a diagram how a reflector and director can be added to a dipole antenna array (Yagi-Uda antenna) is formed to change have directivity antenna radiation pattern.

(4 marks)

i.) Draw the radiation pattern of Yagi-Uda antenna and label the lobe gain.

(2 marks)

ii.) Calculate front-to-back ratio (F/B ratio) of the Yagi-Uda antenna

(3 marks)

d.) Two λ/2 dipoles are separated by 50 km, aligned for optimum reception. The transmitter feeds its antenna with 5 W at 150 MHz. Calculate the: -

i.) Power received at receiving antenna.

(5 marks)

ii.) Voltage at receiving antenna terminal if the impedance is 75Ω.

(2 marks)

-- THE END –

Constant and Formulas

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

2.) Trigonometry theorem: $\sin^2 \alpha = \frac{1}{2}[1 - cos2\alpha]$

3.) Power on resistor load R, $P = \frac{{V_{rms}}^2}{R}$

4.) Mixer output with non-linear devices

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

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

6.) Radio LOS $D_{BL}[km] = 4(\sqrt{h_B} + \sqrt{h_L})$

7.) Power equation for SATCOM link

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

8.) 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

Remarks: Graph paper to be provided