INTI International College Penang
LAUREATE INTERNATIONAL UNIVERSITIES

FINAL
Examination Paper

(COVER PAGE)

Session	:	**April 2017**
Programme	:	Diploma In Electrical And Electronic Engineering (DEEI)
Course	:	**EEE2111: Telecommunication Systems**
Date of Examination	:	1 August 2017 (Tuesday)
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) : **Fam Fook Teng**

Moderator : Assoc. Prof. 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 2017 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) Define the following terms relating to types of signals
   i) Periodic Signals
   ii) Discrete Time Signals
   iii) Random Signals
   iv) Odd Symmetry Signals

(8 marks)

b) In Fourier Analysis, it is possible to construct every periodic signal by using only sine and cosine functions according to a fundamental equation of Fourier.

   i) A square wave function may be represented by the equation:

$$f(x) = \sum_{n=0}^{\infty} \frac{\sin((2n+1)\omega t)}{2n+1}$$

   Expand the equation until $n = 2$ and roughly plot an amplitude vs angular frequency (ω) chart

(4 marks)

   ii) To create complex signals, two waveforms may be combined in a non-linear device. Sketch the time domain waveform for the product of these signals.

(2 marks)

$$f(t) = sin\omega_c t \times sin\omega_m t \ldots\ldots where\ \omega_c \gg \omega_m$$

   Describe an application that uses this waveform function.

(2 marks)

c) In wireless telecommunications, information is carried and transmitted using a much higher frequency carrier.

i) State two reason for doing this, instead of transmitting the low frequency information directly

(5 marks)

ii) The ASTRO satellite system receives its television service channel at 10.7 GHz. Calculate the wavelength of the carrier frequency.

(2 marks)

iii) If the transmitting satellite is 36,000 km above Earth, calculate the delay in receiving the information from the transmitting satellite.

(2 marks)

Question 2:

a) Compare the difference in between the following Amplitude Modulation (AM) Schemes:

	Double Side Band (DSB)	Double Side Band Suppressed Carrier (DSB-SC)	Single Side Band Suppressed Carrier (DSB-SC)
Waveform Equation			
Frequency Components			
Bandwidth			
Power			

(15 marks)

b) Derive the equation of a Double Side Band Amplitude Modulation (DSB-AM) signal.

(2 marks)

Show mathematically that this signal consists of three different frequency components.

(4 marks)

c) Figure 2(c) shows a typical AM Receiver Block diagram.

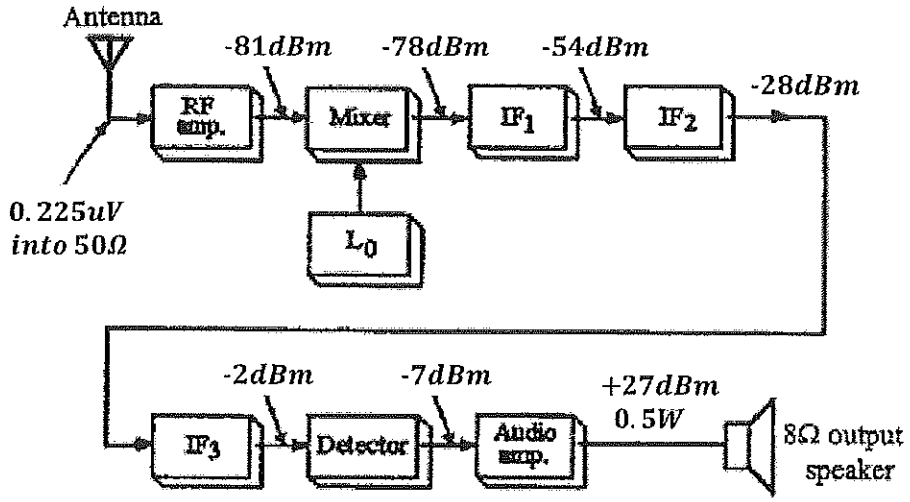

Figure 2(c)

From the information given in Figure 2(c), determine the overall receiver system gain (in dB) from the antenna to the speaker input.

(4 marks)

Question 3:

a) The Tuned Radio Frequency (TRF) receiver was a popular architecture used in early radio development.

i) Explain a major disadvantage of the Tuned Radio Frequency (TRF) receiver architecture.

(3 marks)

ii) How does the Superheterodyne receiver overcome this disadvantage?

(2 marks)

iii) Draw a block diagram of a Superheterodyne receiver, highlighting its major blocks and signal flow.

(8 marks)

b) An FM Superheterodyne receiver architecture has an IF (Intermediate Frequency) of 455 kHz.

i) Calculate the Image Frequency that may potentially cause interference to the receiver, when it receives a signal at 155.125 MHz.

(3 marks)

ii) In your opinion, can the receiver RF amplifier stage provide the selectivity to attenuate the image frequency sufficiently? What steps can be implemented to improve the image rejection further?

(2 marks)

c) A telecommunication engineer who has designed an FM transmitter at 150 MHz with a channel bandwidth 25 kHz, was informed by the US Regulatory body FCC that he needs to reduce the channel bandwidth to 12.5 kHz.
If the modulating frequency used is $m(t) = 2\cos(6\pi 10^3 t)$ and using Carson's design rule:

i) Calculate the frequency deviation used in the 25 kHz BW design?

(2 marks)

ii) Calculate the modulation sensitivity in the 25 kHz BW design?

(2 marks)

iii) With the same modulating signal used, calculate the new modulation sensitivity that the engineer need to design to meet the new 12.5 kHz BW requirement?

(3 marks)

Question 4:

a) Compare the technique, key advantage, key disadvantage, and an application example of Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA).

(8 marks)

b) In wireless digital communication,

i) Why are digital signals converted to analogue signals prior to transmitting the data?

(3 marks)

ii) With an aid of a diagram, show that the minimum bandwidth required for transmission is $\frac{1}{2T_b}$, where T_b is the duration of a bit.

(3 marks)

iii) Determine the minimum bandwidth required if a 64 kbps encoded data stream is used for a digital communication link.

(2 marks)

c) Explain what aliasing means and how it can be prevented?

(3 marks)

d) Twenty-four different analogue signals, each 3 kHz in bandwidth, are digitized using 8 bit PCM and transmitted as a continuous time-multiplexed binary signal.

Determine:

i) The minimum sampling rate for each signal?

(2 marks)

ii) If the minimum sampling rate is used, what is the bit rate for the time- multiplexed output?

(2 marks)

iii) What is the minimum bandwidth for the time-multiplexed output?

(2 marks)

Question 5:

a) The propagation on electromagnetic waves are affected by environment factors on earth.

i) Discuss three of these environmental factors

(6 marks)

ii) One of the effects of severe signal multipath conditions in mobile communications is inter-symbol interference or ISI. With the aid of an illustration, describe how multipath propagation can create ISI issue.

(4 marks)

b) Name the following type of wave

i) This wave that made up of a direct wave between the antennas and a ground-reflected wave

ii) These waves are reflected back by ionosphere and are suitable for short waves that is ranging between 2 MHz and 30 MHz

iii) This wave is suitable for low and medium frequencies and it progress long the surface of the earth. It is normally use for ship communication.

(3 marks)

c) A communication link is being plan connecting the Northern and Central region of West Malaysia. Location of repeater towers have been identified at Penang Hill and Gunung Brinchang, Cameron Highlands. With the following information below, determine the minimum height of the tower at Gunung Brinchang for line-of-sight (LOS) communication.

- Distance of Penang Hill to Gunung Brinchang = 256km
- Altitude of site at Penang Hill is 830m, repeater tower height at Penang Hill is 30m
- Altitude of site at Gunung Brinchang is 1188m

(5 marks)

d) A satellite transmits its TV broadcast channels to consumers in Malaysia. Calculate the power received (in Watts) given the following conditions
- The power gain of the transmitting parabolic dish antenna is 30,000.
- The transmitter drives 2 kW of power into the antenna at 10.7 GHz
- Consumer satellite receiving antenna power gain is 30
- Transmission path is 36,000 km

(7 marks)

Question 6:

a) Define the following antenna terms:
i) Isotropic Radiator
ii) Directivity
iii) Beamwidth
iv) Antenna Gain

(7 marks)

b) Sketch the antenna field patterns produced by the following antennas:
i) Dipole Antenna
ii) Yagi-Uda Antenna
iii) Parabolic Antenna

(6 marks)

c) Sketch a quarter wave antenna.

(4 marks)

Calculate the approximate length of the antenna if it were to operate at 150MHz.

(2 marks)

d) The world largest antenna dish, FAST (Five-hundred-meter Aperture Spherical radio Telescope) antenna measures 500m in diameter. If it is used operate at 1.42 GHz, calculate the power gain (in dB) and beamwidth.

(6 marks)

-- END OF TEST PAPER --

Physical Constants

Speed of light, $c = 2.998 \times 10^8$ m/s
Ambient Temperature, $T_0 = 290$ K
Boltzmann's Constant, $k = 1.38 \times 10^{-23}$ J/K
Gravitational Parameter, $\mu = 398613.52$ km^3 s^{-2}
Radius of the Earth is 6370 km

Bessel Function Table

Bessel Functions shown to 2 decimal places.

Modulation Index	Carrier J_0	Sidebands									
		J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8	J_9	J_{10}
0.0	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	-	-	-	-	-	-
2.5	-0.05	0.50	0.45	0.22	0.07	0.02	-	-	-	-	-
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	-	-
6.0	0.15	-0.28	-0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02	-
7.0	0.3	0.00	-0.3	-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
9.0	-0.09	0.24	0.14	-0.18	-0.27	-0.06	0.20	0.33	0.30	0.21	0.12
10.0	-0.25	0.04	0.25	0.06	-0.22	-0.23	-0.01	0.22	0.31	0.29	0.20