INTI
INTERNATIONAL COLLEGE PENANG (507232-U)
LAUREATE INTERNATIONAL UNIVERSITIES

FINAL
Examination Paper

(COVER PAGE)

Session : AUGUST 2016

Programme : DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING

Course : EEE2111: TELECOMMUNICATION SYSTEMS

Date of Examination : 6 December 2016 (Tuesday)

Time : 5:00pm – 7:00pm Reading Time : Nil

Duration : 2 Hours

Special Instructions :

This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Materials permitted :

Non-Programmable Scientific Calculator

Materials provided : Nil

Examiner(s) : **Mr. Fam Fook Teng**

Moderator : **Dr. Mandeep Singh**

This paper consists of 7 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2111: TELECOMMUNICATION SYSTEMS
FINAL EXAMINATION: AUGUST 2016 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 isotropic radiator. (3 marks)

b) Sketch a quarter wave antenna. Calculate the approximate length of the antenna if it were to operate at 150MHz? (6 marks)

c) A carrier of 150 MHz with amplitude of E_c= 3V is frequency modulated by a signal, $m(t) = 2\cos(6\pi 10^3 t)$, with a modulation index of 1.5. Calculate the:

i. Frequency deviation (2 marks)
ii. Frequency modulation sensitivity (2 marks)
iii. Maximum and minimum instantaneous frequencies (4 marks)
iv. Bandwidth with Carson's rule (4 marks)
v. Bandwidth using Bessel function table (4 marks)

Question 2:

a) Why does one need to convert digital information to analog signals when transmitting data? (6 marks)

b) Why is a telephone channel, normally sampled at a rate of 8k samples per second? What is the impact if the sampling is done at a lower rate? (6 marks)

c) A signal has a bandwidth of 4.5 KHz. Calculate the Nyquist sampling rate. If the signal is digitized to 8 bit resolution, how many bits are generated per second? (4 marks)

d) Define aliasing and how it can be prevented? (3 marks)

e) An analogue signal, band limited to a standard voice frequency (telephone) channel is sampled at the usual rate and coded into 8 bit samples.

i. How many quantization levels are there? (2 marks)
ii. What is the quantization interval for a 10V range? (2 marks)
iii. What bandwidth is required for the coded samples? (2 marks)

Question 3:

a) In a certain communication system, 96 analog signals are multiplexed to form a digital transmission line. Each channel is bandlimited to 3.5KHz and digitized using PCM coding of 8bits/sample. Determine the following parameters for this communication system:
   i. The minimum sampling rate for each signal? (2 marks)
   ii. The minimum bit rate for the time-multiplexed output? (3 marks)
   iii. The minimum bandwidth for the time-multiplexed output? (2 marks)

b) Compare the techniques, advantages and disadvantages of Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA). Provide also, two application examples of where each multiple access techniques are used. (10 marks)

c) Why is synchronization very important in time division multiplexing? (3 marks)

d) Describe the ground wave propagation method in brief and explain two application areas. (5 marks)

Question 4:

a) Discuss any three environmental factors that can affect the transmission and reception of wave in electronic communication. (6 marks)

b) What are the four basic modes that a radio wave is able to propagate from a transmitter to a receiving antenna? (8 marks)

c) Calculate the minimum height of transmitting antenna and receiving antenna to ensure a line of sight condition of microwave repeaters 48km apart. Given the height of both transmitting and receiving antenna is the same. (5 marks)

d) Define polarization of electromagnetic wave and how to receive the maximum transmitted signal. (6 marks)

Question 5:

a) Draw and explain Double Side Band Amplitude Modulation and prove mathematically that the amplitude modulated signals consists of three different frequency components. (10 marks)

b) Draw and explain the architecture of a super heterodyne receiver and explain how this can overcome the limitations of Tuned Radio Frequency receivers. (10 marks)

c) A FM super heterodyne receiver architecture has an IF (Intermediate Frequency) of 455KHz. With the LO (Local Oscillator) tuned to 99.255MHz, it receives the FM broadcast of 98.8MHz. Calculate the Image Frequency that may cause interference to the receiver. (5 marks)

Question 6:

a) Delta modulation and PCM modulation are widely used analog to digital conversion techniques.

i. Illustrate and describe the operation of a delta modulator. (10 marks)

ii. Describe the major advantage and disadvantage of Delta Modulation over Pulse Code Modulation? (5 marks)

b) If an audio signal with a 12 kHz bandwidth using DSB-AM is transmitted within a 1.2 MHz bandwidth, how many channels can be accommodated in the transmission, allowing for a 25% guard band? (3 marks)

c) A telecommunications engineer who has designed an FM transmitter at 150MHz 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. What was the frequency deviation used in the 25 KHz BW design? (2 marks)

ii. What was modulation sensitivity in the 25 KHz BW design? (2 marks)

iii. With the same modulating signal used, what should the new modulation sensitivity that the engineer need to design to meet the new 12.5KHz BW requirement? (3 marks)

--THE END—

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 $J_n(\beta)$ 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	

Identities and Formulas

Tangent and Cotangent Identities

$$\tan\theta = \frac{\sin\theta}{\cos\theta} \qquad \cot\theta = \frac{\cos\theta}{\sin\theta}$$

Reciprocal Identities

$$\sin\theta = \frac{1}{\csc\theta} \qquad \csc\theta = \frac{1}{\sin\theta}$$
$$\cos\theta = \frac{1}{\sec\theta} \qquad \sec\theta = \frac{1}{\cos\theta}$$
$$\tan\theta = \frac{1}{\cot\theta} \qquad \cot\theta = \frac{1}{\tan\theta}$$

Pythagorean Identities

$$\sin^2\theta + \cos^2\theta = 1$$
$$\tan^2\theta + 1 = \sec^2\theta$$
$$1 + \cot^2\theta = \csc^2\theta$$

Even and Odd Formulas

$$\sin(-\theta) = -\sin\theta \qquad \csc(-\theta) = -\csc\theta$$
$$\cos(-\theta) = \cos\theta \qquad \sec(-\theta) = \sec\theta$$
$$\tan(-\theta) = -\tan\theta \qquad \cot(-\theta) = -\cot\theta$$

Periodic Formulas

If n is an integer

$$\sin(\theta + 2\pi n) = \sin\theta \qquad \csc(\theta + 2\pi n) = \csc\theta$$
$$\cos(\theta + 2\pi n) = \cos\theta \qquad \sec(\theta + 2\pi n) = \sec\theta$$
$$\tan(\theta + \pi n) = \tan\theta \qquad \cot(\theta + \pi n) = \cot\theta$$

Double Angle Formulas

$$\sin(2\theta) = 2\sin\theta\cos\theta$$

$$\begin{aligned}\cos(2\theta) &= \cos^2\theta - \sin^2\theta \\ &= 2\cos^2\theta - 1 \\ &= 1 - 2\sin^2\theta\end{aligned}$$

$$\tan(2\theta) = \frac{2\tan\theta}{1 - \tan^2\theta}$$

Degrees to Radians Formulas

If x is an angle in degrees and t is an angle in radians then:

$$\frac{\pi}{180^\circ} = \frac{t}{x} \quad \Rightarrow \quad t = \frac{\pi x}{180^\circ} \text{ and } x = \frac{180^\circ t}{\pi}$$

Half Angle Formulas

$$\sin\theta = \pm\sqrt{\frac{1 - \cos(2\theta)}{2}}$$

$$\cos\theta = \pm\sqrt{\frac{1 + \cos(2\theta)}{2}}$$

$$\tan\theta = \pm\sqrt{\frac{1 - \cos(2\theta)}{1 + \cos(2\theta)}}$$

Sum and Difference Formulas

$$\sin(\alpha \pm \beta) = \sin\alpha\cos\beta \pm \cos\alpha\sin\beta$$

$$\cos(\alpha \pm \beta) = \cos\alpha\cos\beta \mp \sin\alpha\sin\beta$$

$$\tan(\alpha \pm \beta) = \frac{\tan\alpha \pm \tan\beta}{1 \mp \tan\alpha\tan\beta}$$

Product to Sum Formulas

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

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

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

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

Sum to Product Formulas

$$\sin\alpha + \sin\beta = 2\sin\left(\frac{\alpha + \beta}{2}\right)\cos\left(\frac{\alpha - \beta}{2}\right)$$

$$\sin\alpha - \sin\beta = 2\cos\left(\frac{\alpha + \beta}{2}\right)\sin\left(\frac{\alpha - \beta}{2}\right)$$

$$\cos\alpha + \cos\beta = 2\cos\left(\frac{\alpha + \beta}{2}\right)\cos\left(\frac{\alpha - \beta}{2}\right)$$

$$\cos\alpha - \cos\beta = -2\sin\left(\frac{\alpha + \beta}{2}\right)\sin\left(\frac{\alpha - \beta}{2}\right)$$

Cofunction Formulas

$$\sin\left(\frac{\pi}{2} - \theta\right) = \cos\theta \qquad \cos\left(\frac{\pi}{2} - \theta\right) = \sin\theta$$

$$\csc\left(\frac{\pi}{2} - \theta\right) = \sec\theta \qquad \sec\left(\frac{\pi}{2} - \theta\right) = \csc\theta$$

$$\tan\left(\frac{\pi}{2} - \theta\right) = \cot\theta \qquad \cot\left(\frac{\pi}{2} - \theta\right) = \tan\theta$$