



FINAL
Examination Paper

(COVER PAGE)

Session : April 2016

Programme : Diploma in Electrical and Electronic Engineering (DEEI)

Course : EEE2111: Telecommunication Systems

Date of Examination : 28 July 2016, Thursday

Time : 8.00am – 10.00am

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 Calculator

Materials Provided : Answer Booklet

Examiner(s) : Mr. Alan Wong

Moderator : Dr. Mandeep Singh

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

INTI INTERNATIONAL COLLEGE

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
 EEE2111: TELECOMMUNICATION SYSTEMS
 FINAL EXAMINATION: APRIL 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. (2 marks)
- b) Consider a base station transmitting to a mobile station in free space. The following parameters relate to this communication system:
- Distance between base station and mobile station: 8 km
 - Transmitter frequency: 1.5 GHz
 - Base station transmitting power: 10 W
 - Total system losses: 8 dB
 - Mobile receiver noise figure: 5 dB
 - Mobile receiver antenna temperature: 290 K
 - Mobile receiver bandwidth : 1.25 MHz
 - Antenna gains are 8 dB and 0 dB for the base station and mobile station respectively
 - antenna height at the base station and mobile station are 30 m and 3m respectively.
- Calculate the :-
- i. Received signal power at the mobile receiver antenna (based on the two-ray model). (6 marks)
- ii. Signal-to-Noise ratio (SNR) of the received signal. (9 marks)
- c) A carrier of 200 kHz with amplitude of $E_c = 2V$ is frequency modulated by a signal, $m(t) = 3 \cos(6\pi 10^3 t)$ with a modulation index of 4. Calculate the:
- i. Frequency deviation (Δf). (2 marks)
 - ii. Frequency modulation sensitivity (K). (2 marks)
 - iii. Maximum and minimum instantaneous frequencies (f_i). (2 marks)
 - iv. Carson bandwidth. (2 marks)

Question 2:

- a) Why is Shift Keying Modulation required for digital data transmission? (6 marks)
- b) Why is a telephone channel normally sampled at a rate of 8000 samples per second? What are the disadvantages if the sampling frequency is higher or lower than that? (6 marks)
- c) Compare the techniques, advantages and disadvantages of Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA). (13 marks)

Question 3:

- a) Calculate the Nyquist sampling rate of a signal with a bandwidth of 3500 Hz. If the signal is digitized to 8 bit resolution, how many bits are generated per second? (5 marks)
- b) Why is synchronization very important in time division multiplexing? (3 marks)
- c) A digital mobile communication system has a forward channel frequency band 16 MHz. Assume that 90 percent of the bandwidth is used by traffic channels. It is required to support 1150 simultaneous calls using FDMA. The modulation scheme employed has a spectral efficiency of 1.68 bps/Hz. Assuming that the channel impairments necessitate the use of rate $\frac{1}{2}$ FEC codes, calculate the upper bound on the transmission bit rate that a speech coder used in this system should provide?. (6 marks)
- d) i. List one main advantages of Delta Modulation over Pulse Code Modulation. (2 marks)
- ii. Name and describe the two type of quantization error effecting Delta Modulation. How can these two types of quantization error be minimized. (5 marks)
- e) A microwave link consists of repeaters at 50 km intervals. Calculate the minimum height of transmitting antenna and receiving antenna to ensure a line of sight condition. Given the height of both transmitting and receiving antenna is the same. (4 marks)

Question 4:

(a) Define the following terms in wireless transmission:

- i. Bandwidth (2 marks)
- ii. Equalizers. (2 marks)
- iii. ISI (2 marks)
- iv. Aperiodic signal. (2 marks)
- v. Periodic Signals (2 marks)

(b) An FM signal expressed as $V(t) = 50\cos(2\pi 10^7 t + 0.4\cos 2\pi 10^4 t)$ is measured across a $50\ \Omega$ 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 side band at the antenna (2 marks)
- vi. Sum of all side band power at the antenna. (5 marks)

Question 5:

a) 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 sample height 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)

- iv. Why is it generally thought better to send a PCM signal rather than just a sampled (PAM) one? (3 marks)
- v. Why not use fewer bits sample? Or perhaps more? (3 marks)
- b) Draw and explain Double Side Band Amplitude Modulation and prove mathematically that the amplitude modulated signals consists of three different frequency components. (10 marks)
- c) Define Nyquist sampling theorem. (3 marks)

Question 6:

- a) Define polarization of electromagnetic wave and describe how to receive the maximum transmitted signal power. (6 marks)
- b) Draw the waveform and explain about Pulse Amplitude Modulation. (7 marks)
- c) Illustrate and explain what aliasing means and how it can be prevented? (4 marks)
- d) A TDM system uses frame duration of 20 μ s and a sampling frequency of 11 kHz. What could be the maximum number of messages sent on a single transmission channel? (4 marks)
- e) Describe the ground wave propagation method in brief and explain its application (4 marks)

-THE END-

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 | |