The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: ECX6239/EEX6539 Wireless Communications**
Academic Year	: 2019/20
Date	: 10th August 2020
Time	: 13:30-16:30hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **five (05)** questions in **three (03)** pages.
3. Answer all the questions in Section I.
4. Answer only **two (02)** questions in Section II. All questions carry equal marks.
5. Calculators are permitted to use.
6. Relevant charts/ codes are provided.
7. This is a Closed Book Test (CBT).
8. Do not use Red colour pen.

SECTION I

Question 1

a) Explain the three basic propagation mechanisms that affect wireless mobile communication systems and provide suitable examples. (06 marks)

b) Consider an electromagnetic wave transmitted from a transmitting antenna. At a distance 'r' from the transmitter, its electric field component is given as $E_{tx} = \{a.\cos(2\pi f [t - r/c])\}/r$. If the receiver is fixed the received electric field component is given as $E_{rx} = \{b.\cos(2\pi f [t - r/c])\}/r$ where 'c' is the speed of light. (14 marks)

i. Assume that the receiver is moving at a constant velocity 'v' towards the transmitter. Derive an expression for the electric field component of the received signal at a distance 'r1' at time 't=t1' if the initial location of the receiving antenna at t=0 is 'r0'.

ii. The receiver now moves away from the transmitter and stops when it sees an obstructing wall 'd' (where d < r1) distance directly in front of it. Derive an expression for the reflected wave and compute the phase difference between the two waves.

c) A transmitter and a receiver are separated by a distance 2 km. The line-of-sight path is directly obstructed by a tall building of height 75 m which is at 1km away from the transmitter. The heights of the transmitter and the receiver are 50 m and 30 m respectively. All the heights are measured from the ground. Compute the diffraction loss in dB due to the obstacle when a signal of 1900 MHz is transmitted. You may use Figure 1.1 for the computation. (10 marks)

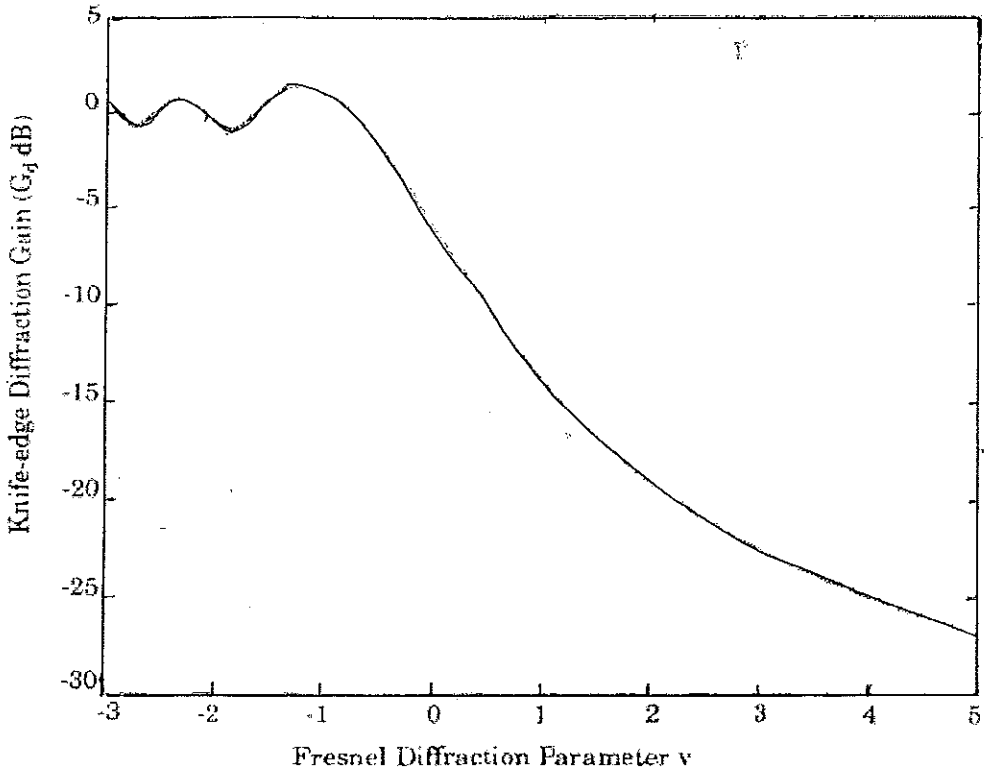

Figure 1.1: Relationship between the Fresnel diffraction parameter vs diffraction loss

Question 2

a) Describe the GSM architecture using a suitable diagram and explain the functions of the main sub-systems. (10 marks)

b) Discuss the advantages and limitations of frequency reuse and cell splitting techniques which aims at increasing the capacity in a cellular system. (04 marks)

c) Explain the spread spectrum concept using a general model. (06 marks)

d) Consider the uplink of a GSM system where the signal to noise ratio (SNR) required is 11 dB. Assume a maximum mobile transmit power of 1.0 W. Consider 0 dB antenna gain at the mobile and 12 dB gain at the base station (BS). Path loss is given by the urban area Hata model, where frequency (f) is 850 MHz, BS antenna height is 30 meters, mobile height is 1 meter. Consider noise figure (N) to be 3 dB and the system is noise limited. Calculate the maximum range of the link. (10 marks)

SECTION II

Question 3

a) Derive an expression for the average signal-to-noise ratio (SNR) in a selection diversity receiver with 'M' branches. (10 marks)

b) Consider a selection diversity receiver with five branches. Each branch experiences an independent Rayleigh fading channel. Consider the average SNR value is 20dB in each branch. Calculate the probability that SNR will drops below 10dB in all the branches. (05 marks)

c) Describe the operation of an OFDM transmitter in an LTE system with a suitable diagram. (05 marks)

Question 4

a) Explain the power control mechanisms used in the CDMA IS-95 system and their limitations under fast fading conditions. (04 marks)

b) Explain the operation of an M branch Rake receiver. (06 marks)

c) In spread spectrum terminology, 'chip' is used to refer to the sample period of a symbol. If there are two symbols, each as 'n' chips, transmitted over two pseudo random sequences x1 and x2, explain how the signal detection is performed when the Rake receiver operation is implemented using matched filters.
In your answer consider the additive noise component at the receiver. State any assumptions that you make. (10 marks)

Question 5

a) Explain linear modulation and discuss its advantages and limitations. (03 marks)

b) Define the terms (i) power efficiency and (ii) bandwidth efficiency related to digital modulation. (05 marks)

c) Draw the constellation diagram of the quadrature phase shift keying (QPSK) digital modulation scheme. (04 marks)

d) (i) Explain how the bits are encoded in binary phase shift keying (BPSK). (04 marks)
(ii) What can you conclude about the energy efficiency of a modulation scheme if its constellation diagram is (a) densely packed with lot of points and (b) sparse with only a few points. (04 marks)