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

Study Programme	:	Bachelor of Science Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**EEX6339 Wireless Communications**
Academic Year/Semester	:	2023/2024
Date	:	11th March 2025
Time	:	0930-1230h
Duration	:	3 hours

General instructions

1. This is a closed book examination.
2. There are four (04) compulsory questions in three (03) pages. Answer all the questions.
3. Do not use red colour pen to write the answers.
4. Please remember to write your registration number in the space provided above and in the answer script. **Do not write your name.**

Question 1 **[20 marks]**

Consider a wireless communication system with a transmitter operating at 50W applied to a transmitting antenna of gain 1.5. Assume line of sight path for propagation between the transmitter and receiver. The receiver is placed at 500m from the transmitter and operates with an antenna of gain 1.25. The transmitted signal frequency is 900MHz.

i) Calculate the transmit power in dBm. State any assumption(s) you make for the calculation.

ii) Calculate the received power in dBm.

If the transmitting antenna and the receiving antenna are now raised above the ground and placed at a height of 2m and 1m respectively.

iii) Calculate the received power.

iv) Calculate the path loss.

Question 2 **[30 marks]**

a) Describe the effects of (i) diffraction and (ii) scattering on wireless signal propagation in GHz range.

b) Describe the impact on signal attenuation and the variation of the Fresnel Kirchhoff diffraction parameter for the following two scenarios.

i) SCENARIO 1: Signal frequency is doubled without changing the heights of the knife-edge obstacle, transmitter and receiver antennas.

ii) SCENARIO 2: Signal frequency remains the same. The height of the knife-edge obstacle is doubled. Heights of the transmitter and receiver remain unchanged.

iii) SCENARIO 3: The knife edge is placed closer to the receiver. Signal frequency and the heights of the transmitter, knife-edge obstacle and the receiver remain unchanged.

Determine which scenario increases signal attenuation. Give reasons.

Question 3 **[30 marks]**

a) Describe how antenna diversity at the transmitter is utilized to increase the capacity in a cellular mobile communication system within a cell without increasing the cell size.

b) Derive an expression for the total number of channels within a cellular network for a frequency reuse parameter of 7. Consider that the total number of cells in the network is "N". Assume that there's a fixed channel allocation of "k" channels per cell.

c) Read the following excerpt and answer the questions:

"Multi-user Multiple-Input Multiple-Output (MIMO) offers big advantages over conventional point-to-point MIMO: it works with cheap single-antenna terminals, a rich scattering environment is not required, and resource allocation is simplified because every active terminal utilizes all of the time-frequency bins. However, multi-user MIMO, as originally envisioned with roughly equal numbers of service-antennas and terminals and frequency division duplex operation, is not a scalable technology. Massive MIMO (also known as "Large-Scale Antenna Systems", "Very Large MIMO", "Hyper MIMO", "Full-Dimension MIMO" and "ARGOS") makes a clean break with current practice through the use of a large excess of service-antennas over active terminals and time division duplex operation. Extra antennas help by focusing energy into ever-smaller regions of space to bring huge improvements in throughput and radiated energy efficiency.."

Reference: Larsson, E.G., Edfors, O., Tufvesson, F. and Marzetta, T.L., 2014. Massive MIMO for next generation wireless systems. IEEE communications magazine, 52(2), pp.186-195.

i) Draw the schematic diagram of a MIMO antenna diversity with "N" transmitting and "M" receiving antennas.

ii) Draw the schematic diagram of a SIMO antenna diversity with "M" receiving antennas.

iii) Compare the power requirements for transmitting 'k' orthogonal signals using the MIMO setup in (i) and (ii). State any assumptions you make in this comparison.

iv) Describe three advantages of using multi-user MIMO compared to conventional point-to-point MIMO systems.

Question 4 **[20 marks]**

a) Name three (03) advantages of OFDM over single-carrier modulation.

b) Identify the role of the cyclic prefix (CP) in OFDM?

c) Describe three (03) main characteristics of mobile adhoc networks.

d) Discuss how diversity and equalization contribute to 5G and modern wireless systems.