GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY

Faculty of Engineering

Department of Electrical, Electronic and Telecommunication Engineering

BSc Engineering Degree

Semester 6 Examination – October 2024

Intake 39 – ET

WIRELESS AND MOBILE COMMUNICATION I

(ET 3202)

Time allowed: 2 hours 02nd October 2023

ADDITIONAL MATERIAL PROVIDED

Nil

INSTRUCTIONS TO CANDIDATES

This paper contains 5 questions on 09 pages.

Answer ALL 5 questions.

This is a closed book examination.

This examination accounts for 70% of the module assessment. The marks assigned for each question and parts thereof are indicated in square brackets.

If you have any doubt as to the interpretation of the wordings of a question, make your own decision, but clearly state it on the script.

Assume any reasonable values for any data neither given in nor provided with the question paper, clearly make such assumptions made in the script.

All examinations are conducted under the rules and regulations of the KDU.

Learning Outcome (LO)	Questions that assess LO	Marks allocated (Total 70%)
LO1	Q1	14
LO2	Q4, Q5	17
LO3	Q2,Q3	17
LO4	Q5	12
LO5	Q5, Q3	10

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All the symbols have their usual meaning

Question 01

a. Explain basic propagation mechanisms in briefly. [03 marks]

b. Explain the term "Brewster angle (θ_B)" and calculate the Brewster angle for a wave impinging on ground having a permittivity of $\varepsilon r = 4$. [03 marks]

c. A mobile is located 3 km away from a base station and uses a vertical $\lambda/2$ dipole antenna with a gain of 3 dB to receive cellular radio signals. The E-field at 500m away from the transmitter is measured to be 5 x 10-3 V/m. The carrier frequency used for this system is 1.8 GHz.

i. Calculate the length and the effective aperture (A_e) of the receiving antenna.

ii. Calculate the received power at the mobile using the 2-ray ground reflection model, assuming the height of the transmitting antenna is 30 m and the receiving antenna is 2 m above ground. [06 marks]

Hint : you may use following equations ;

$$Recieved\ E-Field:\ E_R = \frac{2E_o d_o 2\pi h_t h_r}{d.\lambda.d}$$

$$Recieved\ Signal\ Power:\ P_r(d) = \frac{|E_R|^2}{120.\pi}.A_e = \frac{P_r G_t G_r \lambda^2}{(4\pi)^2 d^2}$$

d. Briefly explain the Two ray reflection model and derive equations for followings:

i. Path Difference.

ii. Phase difference.

iii. Time Delay.

[05 marks]

e. Briefly explain different kinds of fading effets in wireless communication, and how do they affect to quality of the signal. [03 marks]

Question 02

a. Most network operators in the industry have long struggled with bandwidth limitations and the challenge of efficiently managing limited spectrum resources. To address this issue, a concept known as Frequency Reuse was introduced, which helped revolutionize how networks could maximize their capacity. Explain how frequency reuse works and why it became such a vital solution to the bandwidth limitation problem. [02 marks]

b. Explain the following key concepts related to access techniques in mobile communication:

i. Fixed and Dynamic Channel Assignment Techniques.
ii. Soft Handoff and Hard Handoff, with examples of proper and improper handoff situations.
iii. Concept of Co-Channel Interference (CCI) and Adjacent Channel Interference (ACI). [06 marks]

c. A receiver in an urban cellular radio system detects a 1 mW signal at d_o=1 m from the transmitter. It is observed the received power at given distance D is −100 dBm. A measurement team has determined that the average path loss exponent in the system is n=3. Determine the major radius of each cell if a 7- cell reuse pattern is used. What is the major radius if a 4 - cell reuse pattern is used? [05 marks]

Where : d_o– Referance distance
n – Path loss exponent

d. Discuss the key techniques for improving coverage in mobile networks. [02 marks]

e. An urban area has a population of 2 million residents. Three competing trunked mobile networks (systems A, B, and C) provide cellular service in this area. System A has 394 cells with 19 channels each, system B has 98 cells with 57 channels each, and system C has 49 cells, each with 100 channels. Find the number of users that can be supported at 2% blocking if each user averages 2 calls per hour at an average call duration of 3 minutes.

Assuming that all three trunked systems are operated at maximum capacity, compute the percentage market penetration of each cellular provider.

[05 marks]

Hint : Figure Q.2a