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UNIVERSITY EXAMINATIONS 2024/2025

FOURTH YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING AND BACHELOR OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING

EET 3421: WIRELESS AND MOBILE COMMMUNICATIONS

DATE: JANUARY 2025 **TIME: 2 HOURS**

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

a) Define the following terms.
   i. Grade of service (GOS).
   ii. Dwell time
   iii. Handoff (3 Marks)

b) Explain the types of multipath fading encountered in wireless communication systems. (3 Marks)

c) Consider an interference in the Advanced Mobile Phone System (AMPS) cellular system which uses FM and 30 kHz channels. The six closest cells are close enough to create significant interference and they are all approximately equal distance from the desired base station. Find the minimum cluster size so that the acceptable voice quality is attained when SIR is greater than or equal to 18 dB. Assume the path loss exponent, n = 4. (3 Marks)

d) In a cellular system with total of 917 radio channels available for handling traffic. The area of a cell is 4 km^2 and the total area is 1400 km^2 with cluster of 7. Calculate the system capacity. (4 Marks)

e) Differentiate between pure ALOHA and slotted ALOHA. (4 Marks)

f) Explain three applications of a wireless local area network (WLAN). (3 Marks)

g) Mobile Internet Protocol (IP) was developed to enable users to maintain Internet connectivity while moving from one Internet attachment point to another. To support these operations, Mobile IP includes three basic capabilities. Discuss these capabilities. (3 Marks)

h) IMT-2000 has evolved into 4G and 5G standards. Discuss the limitations of IMT-2000 that prompted the development of these newer technologies. (3 Marks)

i) Explain how orthogonal Frequency Division Multiplexing (OFDM) helps in minimizing intersymbol interference (ISI) in high data rate communication systems. (4 Marks)

QUESTION TWO (15 MARKS)

a) Compare space diversity and frequency diversity as techniques for mitigating fading in wireless communication systems. (4 Marks)

b) Wideband Code-Division Multiple-Access (W-CDMA) is one of the main technologies for the implementation of third-generation (3G) cellular systems. State four key features of WCDMA processing units. (4 Marks)

c) Consider a mobile phone system cell using a frequency of 900 MHz providing coverage to an urban environment like the Pangani area of Nairobi. The height of the receiver is 2 meters and the cell site antenna is 34 meters tall. The mobile terminal receivers have a sensitivity of –90 dBm. Using the Okumura-Hata propagation model determine what power level the base station must operate at to have a cell coverage radius of 1.6 km. (7 Marks)

QUESTION THREE (15 MARKS)

a) Most systems give high priority to handoffs over initiating calls. Briefly discuss two strategies for prioritizing handoffs. (4 Marks)

b) Describe the Global System for Mobile communication (GSM) call origination process. (4 Marks)

c) For a cellular system with a total bandwidth of 15 MHz uses 10 kHz simplex channels to provide full duplex voice and control channels. For 12 cell reuse pattern and 1 MHz of the total bandwidth is allocated for control channels.

i. Calculate the total available channels.

ii. Determine the number of control channels.

iii. Calculate the number of voice channels per cell. (7 Marks)

QUESTION FOUR (15 MARKS)

a) When a mobile user moves from one PCS system to another, the system should be informed of the current location of the user through registration (location update) and location tracking operations. Describe the registration procedure. (4 Marks)

b) The parameters of a satellite uplink operating in the ku-band are shown in Fig. Q4(b).

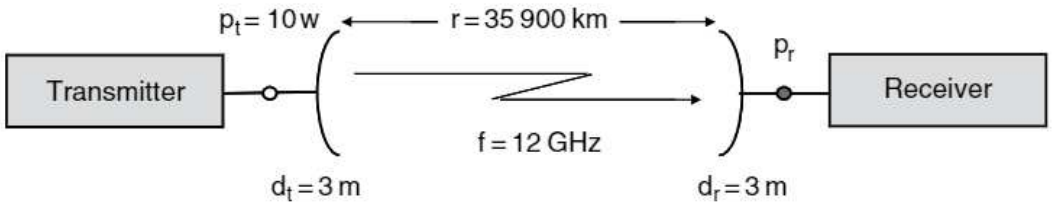

Fig. Q4(b)

The antenna efficiency is 55 % for both antennas. The satellite is in a GSO location, with a range of 35,900 km. The frequency of operation is 12 GHz. These are typical parameters for a moderate rate private network VSAT uplink terminal. Determine the received power for the link. (5 Marks)

c) Describe the elements of the operation and support subsystem of the GSM architecture. (6 Marks)

QUESTION FIVE (15 MARKS)

a) A certain wideband wireless channel has a delay spread of 2 μs. In order to overcome ISI, assume a requirement that $Ts \geq 10\tau$, where Ts is the symbol time and τ is the channel delay spread.

   i. Determine the maximum bandwidth allowable in this system if the ISI constraint is to be met without using multicarrier modulation.

   ii. If multicarrier modulation is used, and a 15 MHz bandwidth is desired, determine the required number of subcarriers. (5 Marks)

b) The Common Control Channels (CCCH) are one-way channels used for establishing links between the mobile station and the BTS for any ongoing call management. Describe three CCCH logical channels. (6 Marks)

c) General Packet Radio Service (GPRS) is a mechanism for transporting high-speed data over GSM. It introduces new network elements to the existing GSM network. Discuss two of these elements. (4 Marks)