CHUKA **UNIVERSITY**

Knowledge is Wealth (*Sapientia divitia est*)

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DEPARTMENT OF PHYSICAL SCIENCES

EXAMINATION FOR BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EENG 481: WIRELESS AND MOBILE COMMUNICATION I

QUESTION ONE

a. Define the following terms as used in telecommunication (2 Mks)
   i. Cell splitting
   ii. Grade of Service (GOS
   iii. Holding Time
b. Explain four factors that influence the handoff process (6 Mks)
c. A cellular service provider decides to use a digital TDMA scheme which can tolerate an SIR of 15 dB in the worst case. Assume n = 4 and consider trunking efficiency.
   i. Find the optimal value for N for omni-directional antennas, 120^0 sectoring antennas, and 60^0 sectoring antennas (3 Mks).
   ii. Should sectoring be used? If so, which case should be used (2 Mks)?
d. An engineer is designing a communications link at 3 GHz where the receiver sensitivity is such that $1\mu W$ of power is needed to overcome receiver noise. The receiving antenna gain is 8dB, the transmitter antenna gain is 10dB, the transmitting power level is 25 Watts, and the distance between the two antennas is 1km. Will the communications link work (4 Mks)?
e. Diversity helps to stabilize a link and improves performance by providing the receiver with multiple versions of the same signal. List and explain three diversity techniques in existence. (6 Mks)
f. Compare between LTE and Advanced-LTE features (3 Mks)
g. A system design engineer is in charge of estimating the system capacity and deciding on the cell radius R for a service area of 1765 km^2 that would support 336 traffic channels. After inspecting the cell-site transmitter power and the antenna height, he decided that the cell radius should be 1.64 Km. Considering a hexagonal topology, how many clusters should cover the service area for a reuse distance of 5.68 Km (4 Mks)?

QUESTION TWO

a. You are asked to design a cellular system for a tropical island with 60,000 total users. The system uses two 10 KHz simplex channels to provide full duplex voice and control channels. You will deploy 100 base stations with omnidirectional antennas. The following specifications are given to you:
   - The average user makes 1 call per hour of length 2 minutes
   - You may assume that users are distributed equally in all base stations
   - Due to the dense tropical vegetation, the path loss exponent is n = 4.2
   - The required SIR is 19 dB
   - The blocked-calls cleared system requires a G.O.S of 5%
   - The topology used to model the problem is hexagonal

   i. What is, in MHz, the minimum needed bandwidth to be allocated for this system(3 Mks).?
   ii. Find the decrease in trunking efficiency if the system uses 60^0 sectoring. Assume the same reuse factor (3 Mks).
   iii. Find the increase in capacity if the system uses 60^0 sectoring. Assume the same SIR of 19 dB (3 Mks)..

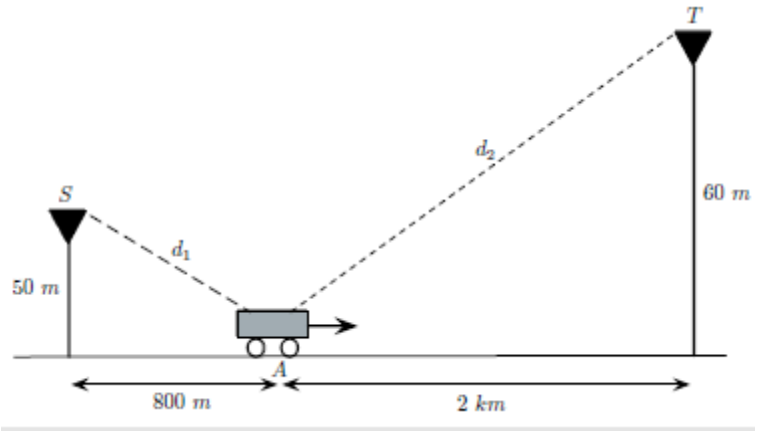
b. For a certain cellular system, the allocated spectrum is 20 MHz and a 30 KHz channel spacing is used for uplink and downlink separation. The reuse ratio for this system is 7, and the cluster of cells is duplicated 10 times. Find the number of simultaneous communications that can be supported by each cell (3 Mks).

c. Discuss four advantages of cellular systems with multiple small cells over few larges cells (8 Mks)

d. Find the probability of delay for a block calls cleared trunked system, where the number of channels per cell is 3, the number of users is 20, and each user averages 3 calls per hour at an average call duration of 1 minute. Find the GOS of the system where calls are are delayed greater than 1 min (3 Mks).

QUESTION THREE

a. Consider a mobile user driving his car at a constant speed of 72 km/hr . Initially, his traffic was serviced by base station S. Assume that the only other available base station, denoted T, is located 2.8 km from S. The minimum power level needed to maintain an acceptable voice quality is equal to 1.4×10^{-18} W. Take $P_0 = 10^{-12}$ W at $d_0 = 1$ m, and n = 2.



i. If a handoff request is sent at position A, find the Pr ,HO and Δ (3 Mks).
ii. Let B be the position of the car once the handoff has been accomplished. The power received by the mobile user from T at position B is 0.69×10^{-18} W. Find the time t needed to complete the handoff (3 Mks).

b. WiMAX was a great 4G technology. Why was it preferred. (4 Mks)
c. Discuss two channel Assignment Strategies used in cellular communication (6 Mks)
d. Design a hypothetical experiment to measure path loss Ls, at frequencies f_1 = 30 MHz and f_2 = 60 MHz, when the distance between the transmitter and receiver is 100 Km. Find the effective area of the receiving antenna, and calculate the path loss in decibels for each case (4 Mks).

QUESTION FOUR

a. A certain city has an area of 1,300 square miles and is covered by a cellular system using a seven-cell reuse pattern. Each cell has a radius of four miles and the city is allocated 40 MHz of spectrum with a full duplex channel bandwidth of 60 kHz. Assume a GOS of 2% for an Erlang B system is specified. If the offered traffic per user is 0.03 Erlangs, compute
   i. the number of cells in the service area (2 Mks),
   ii. the number of channels per cell (1 Mk),
   iii. traffic intensity of each cell (1 Mk),
   iv. the maximum carried traffic (1 Mk),
   v. the total number of users that can be served for 2% GOS (1 Mk),
   vi. the number of mobiles per unique channel (where it is understood that channels are reused) (1 Mk),
   vii. the theoretical maximum number of users that could be served at one time by the system (1 Mk)
b. Determine the proper spatial interval required to make small propagation measurements which assume that consecutive samples are highly correlated in time. How many samples will be required over 10m travel distance if f_c = 1900 MHz and v = 50m/s? How long would it take to make these measurements, assuming they could be made in real time from a moving vehicle? What is the Doppler spread B_D for the channel (6 Mks)?
c. Consider interference in the U.S. 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 a path loss exponent n = 4 (3 Mks).

d. Discuss three basic communication access technologies (3 Mks)