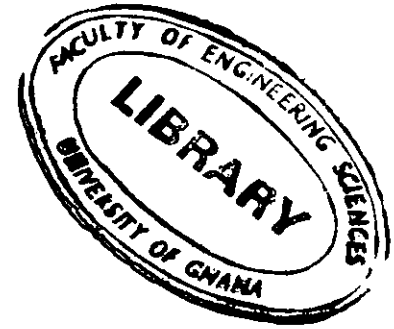




UNIVERSITY OF GHANA

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BACHELOR OF SCIENCE IN ENGINEERING
SECOND SEMESTER EXAMINATIONS: 2015/2016

DEPARTMENT OF COMPUTER ENGINEERING
CPEN 406: WIRELESS COMMUNICATION SYSTEMS (3 Credits)

INSTRUCTION: *Answer any five (5) Questions of your choice.*

TIME ALLOWED: *THREE (3) HOURS*

1. (a) Briefly explain the concept behind the cellular communication system and give two (2) reasons why cellular communication is important. [4 marks]
(b) With the support of a suitable diagram, explain how wireless communication works between two mobile devices. [6 marks]
(c) A wireless receiver with an effective diameter of 250 cm receives signals at 20 GHz from a transmitter that transmits at 30 mW and a gain of 30 dB. Find the gain of the receiver antenna and the power that is received if the receiver is 5 km away from the transmitter. [6 marks]
(d) Explain the difference between fast fading and slow fading in wireless cellular communication systems? [4 marks]
2. (a) What do you understand by the term “*gain of an antenna*”? Briefly explain the difference between omnidirectional and directional types of wireless transmission configuration and give one example of each type. [6 marks]
(b) You have been tasked to design a 2 km 2.5 GHz wireless link between the School of Engineering and the University NOC. The radio at the NOC is connected to an omnidirectional antenna with a gain of 10dBi while the radio at School of Engineering is connected to a sectorial antenna with a 14dBi gain. The power of the transmitting radio at the NOC is 100mW (20dBm) and its sensitivity is -89dBm and that of the radio at Engineering is 30mW (15dBm) and its sensitivity is -

82dBm. Assume the connecting cables used for the connection at both NOC and Engineering are short and have a loss of 2 dB. Estimate the feasibility of the design. Use the free space wireless model for your work. [10 marks]

(c) What is the difference between adjacent channel interference and co-channel interference? [4 marks]

3. (a) Explain why the hexagonal-shaped structure is mostly preferred for modelling in wireless communication system than the octagon-shaped structure. [4 marks]
- (b) Assume the antenna at the base station near the Great Hall transmits signals at 5 W and 1900 MHz. If the gains of the transmitter and receiver antennas are unity, find the power at the receiving antenna if it is located 2 km from the transmitter. Assume the propagation is taking place in free space. [6 marks]
- (c) Explain the concept of Doppler shifts in wireless communication. Suppose an antenna at a base station transmits wireless signals at 900 MHz and a receiver is travelling at a speed of 40 km/h. Find the: [5 marks]
- (i) Doppler shift or frequency;
- (ii) Coherence time;
- (d) What is frequency reuse? A new wireless service provider decided to employ a cluster of 4 cells as the module for frequency reuse. Find the reuse distance and the reuse factor of the system if the boundary area of a cell is 12 km. [5 marks]
4. (a) Explain clearly the difference between guard-band and guard-time and explain why they are important in a cellular system. [4 marks]
- (b) A point-to-point wireless link between a mobile station and a base station has a bandwidth of 2 MHz to 6 MHz and a SNR of 35 dB. Find the capacity of the channel and the number of signal levels required to represent the signal. [6 marks]
- (c) Suppose the FDMA modulation technique is used in 4 (b) to multiplex the channel among the users. Find the number of channels supported if a band-guard of 10 kHz is used and the bandwidth per voice channel is 30 kHz. [5 marks]
- (d) If the TDMA technique is used instead of the FDMA, find the number of channels supported if the band-guard is 10 kHz and 10 voice channels per radio channel is allowed and the bandwidth per channel is 30 kHz. [5 marks]
5. (a) A mobile device keeps a traffic channel busy for an average of 5% time and an average of 60 requests per hour is generated. What is the Erlang value? [5 marks]
- (b) Suppose a wireless service provider has 20 cells to cover its whole service area,

with each cell having 40 channels. Find the number of users the service provider can support if a call blocking probability of 2% is required. Assume that each user makes an average of 3 calls per hour and each call has an average duration of 3 minutes. [9 marks]

(c) Find the probability of an arriving call being delayed by the system. [6 marks]

6. (a) What do you understand by the term "*hand-off*" in cellular communication? With the support of a suitable diagram, briefly explain how hand-off occurs in wireless communications and how mobile service operators implement hand-off to minimize oscillatory effects. [8 marks]
- (b) Explain the concept of multiple channel access sharing in wireless system and the potential problems associated with the sharing. [4 marks]
- (c) Briefly describe two (2) protocols that could be used to handle multiple channel access issues. For each protocol, indicate the key issue involved. [4 marks]
- (d) Briefly explain the following multiple division access techniques: *FDMA*, *TDMA*, *CDMA*, and *SDMA*. [4 marks]

