



# UNIVERSITY OF MORATUWA

## FACULTY OF ENGINEERING

### DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

B.Sc. Engineering

2009 Intake Semester 7 Examination

### CS4492 WIRELESS AND BROADBAND NETWORKING

Time allowed: 2 Hours

September 2013

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**ADDITIONAL MATERIAL:** *None*

#### **INSTRUCTIONS TO CANDIDATES:**

1. This paper consists of 7 questions in 6 pages.
2. Answer ALL questions in Section A and any THREE (3) questions (out of 4) from Section B.
3. Start answering each of the main questions on a new page.
4. The maximum attainable mark for each question is given in brackets.
5. This examination accounts for 60% of the module assessment.
6. This is a closed book examination.  
***NB: It is an offence to be in possession of unauthorised material during the examination.***
7. Only calculators approved by the Faculty of Engineering are permitted.
8. Assume reasonable values for any data not given in or with the examination paper. Clearly state such assumptions made on the script.
9. In case of any doubt as to the interpretation of the wording of a question, make suitable assumptions and clearly state them on the script.
10. This paper should be answered only in English.

## SECTION A

## Question 1 (10 marks)

Select the most appropriate answer. Write the corresponding sub-question number and the answer number in your answer book. [10 × 1]

- (i) Wavelength of an electromagnetic wave travelling in space is 60 cm. What is its frequency? Assume the speed of light is  $3 \times 10^8$  m/s.
- a) 500 MHz b) 3 GHz  
 c) 5 GHz d) 15 GHz
- (ii) Reflection of wireless signals occurs when
- a) wavelength is constant b) wavelength  $\ll$  size of object they hit  
 c) wavelength  $\approx$  size of object they hit d) wavelength  $\gg$  size of object they hit
- (iii) Quadrature Amplitude Modulation uses
- a) Amplitude-Shift Keying with 4 levels of amplitudes  
 b) Amplitude-Shift Keying and Code Division Multiplexing  
 c) Amplitude-Shift Keying and Frequency-Shift Keying  
 d) Amplitude-Shift Keying and Phase-Shift Keying
- (iv) Which is NOT a topology supported by the IEEE 802.15.4/ZigBee standards?
- a) Cluster tree topology b) Peer-to-peer topology  
 c) Ring topology d) Star topology
- (v) The channel access mechanism for Wireless LANs as defined by IEEE 802.11 standard is?
- a) CDMA b) CSMA/CA  
 c) CSMA/CD d) GSM
- (vi) Which of the following statements are true about channels in 2.4 GHz WLANs?
- (p) 11 channels are supported in North America and most parts of the world  
 (q) Direct Sequence Spread Spectrum (DSSS) technology can use only channels 1, 6, and 11 simultaneously  
 (r) Orthogonal Frequency-Division Multiplexing (OFDM) enables the use of multiple channels in the same frequency
- a) (p) and (q) only b) (p) and (r) only  
 c) (q) and (r) only d) All three
- (vii) Which of the following GSM network element dynamically stores the “subscriber information needed to handle incoming/outgoing calls”?



## SECTION B

Answer any **THREE (3)** questions.

### Question 4 (25 marks)

- (i) Friis Free-space equation (given below) can be used to find the signal strength at a given distance  $d$ .

$$P_R(d) = \frac{P_T G_T G_R \lambda^2}{(4\pi)^2 d^2}$$

A synchronous satellite is positioned 60,000 km from the surface of the Earth. It transmits a 12 GHz wireless signal with a transmit power of 6 W. Transmitting antenna gain is 18 dB.

- a) Find the received power for the link from the satellite to a terrestrial antenna with a gain of 50 dB. Assume the speed of light is  $3 \times 10^8$  m/s. [8]
- b) Will the received power be same under heavy rain? Briefly explain. [2]
- (ii) What is the Exposed Terminal problem and how can it be addressed? Briefly explain using suitable diagrams. [5]
- (iii) What are the major features of Digital Subscriber Line (DSL) technology? [4]
- (iv) What is Discrete Multi-Tone (DMT) technique and how is it used in DSL? [6]

### Question 5 (25 marks)

- (i) What are the pros and cons of Spread Spectrum technology? [5]
- (ii) Using a suitable diagram briefly explain how the Direct Sequence Spread Spectrum technology works. [6]
- (iii) In a Frequency-Hopping Spread Spectrum system, a hopping bandwidth of 50 MHz and a frequency spacing of 25 KHz is used.
- a) How many different frequencies ( $M$ ) are there? [2]
- b) Given  $M$  frequencies, how many bits are needed by the modulation scheme to determine which frequency to use? [2]
- (iv) Inter-Vehicle Communication is considered to be the one of the key technologies to look for in the near future.
- a) What are the applications of Inter-Vehicle Communication? Explain with examples. [4]
- b) Briefly describe the challenges faced by Inter-Vehicle Communication and possible solutions to them. [6]

**Question 6 (25 marks)**

- (i) Based on empirical evidence, it has been found that it is more reasonable to model the received power in an indoor environment as a log-distance path-loss model (given below).

$$P_R(d) = P_0(d_0) - 10n_p \log(d/d_0) + X_\sigma$$

A signal is sent using a stationary transmitter that emits a transmission power of 6.5 mW. The frequency of the transmitter is 1.9 GHz, and gains of both the transmitting and receiving antennas are 1. Suppose the reference distance for an office environment with soft partitioning is 10 m.

- a) Identify each term in the log-distance path-loss model. [2]
- b) Determine received power at 10 m. You may use Table Q6 to identify suitable parameter values. [4]
- c) Determine received power at 60 m in an office environment with soft partitioning, given power at the reference distance. Hint: as the devices are stationary, you can ignore the effects of  $X_\sigma$ . [5]
- d) Find the total path loss in dBm. [2]
- e) Will a wireless module with a receiver sensitivity of -90 dBm be sufficient to detect this signal? [2]
- (ii) Compare and contrast Mesh, Ad-Hoc, and Wireless Sensor Networks. [6]
- (iii) Using a suitable example, briefly describe Data Centric Routing in the context of Wireless Sensor Networks. [4]

**Table Q6** – Path-loss exponent and standard deviation in different buildings. Source: S. Rao, “Estimating the ZigBee transmission-range ISM band,” EDN, May 2007, pp. 67-72.

Building	Frequency (MHz)	Path-loss exponent, n	Standard deviation (dB)
Retail store	914	2.2	8.7
Grocery store	914	1.8	5.2
Office, hard partition	1500	3	7
Office, soft partition	900	2.4	9.6
Office, soft partition	1900	2.6	14.1
Factory, line of sight	1300	2	3
Suburban, indoor street	900	3	7
Factory, obstructed path	1300	3.3	6.8

**Question 7 (25 marks)**

- (i) Mobility is important in WLANs. Briefly discuss to what extent is mobility supported by current implementations. [4]
- (ii) Briefly describe how Mobile IP is supported in IPv4 vs. IPv6. [4]
- (iii) Briefly explain the security issues in WLANs and how those can be addressed using existing techniques and best practices. [8]
- (iv) What are the key technological differences between 3G and 4G Wireless Metropolitan Area Networks (WMAN) technologies? [5]
- (v) Briefly explain what is Long Term Evolution (LTE) and various deployment options in LTE (based on cell size)? [4]

----- END OF THE PAPER -----