

2017/2018 SEMESTER ONE EXAMINATION

Diploma in Engineering with Business
3rd Year Full Time

WIRELESS TECHNOLOGY APPLICATIONS

Time Allowed: 2.0 Hours

Instructions to Candidates

1. The examination rules set out on the last page of the answer booklet are to be complied with.
2. This paper consists of **TWO** sections :

| | | |
|-----------|---|---|
| Section A | - | 10 Multiple Choice Questions, 2 marks each. |
| Section B | - | 8 Short Questions, 10 marks each. |
3. **ALL** questions are **COMPULSORY**.
4. All questions are to be answered in the answer booklet. Start each question in Sections B on a new page.
5. Fill in the Question Numbers, in the order that they were answered, in the boxes found on the front cover of the answer booklet under the column “Question Answered”.
6. This paper consists of 12 pages.

SECTION A

MULTIPLE CHOICE QUESTIONS [2 marks each]

1. Please **tick** your answers in the **MCQ box** behind the front cover of the answer booklet.
2. No marks will be deducted for incorrect answers.

A1. Which one of the following wireless technologies is best suited for industrial automation and control application?

- (a) ZigBee
- (b) UWB
- (c) Bluetooth Low Energy (BLE)
- (d) Bluetooth Classic

A2. A wireless system is shown in Figure A2. Which one of the following options is the received power (P_{rx}) at the receiver?

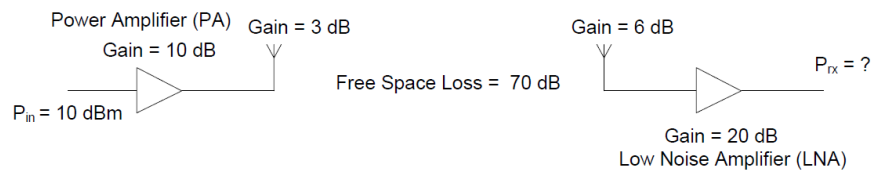


Figure A2

- (a) -30 dBm
- (b) -21 dBm
- (c) -31 dBm
- (d) -41 dBm

A3. Figure A3 shows the block diagram of an RFID reader. Which one of the functional blocks does the demodulation?

- (a) Transmitter
- (b) Encoder
- (c) Decoder
- (d) Receiver

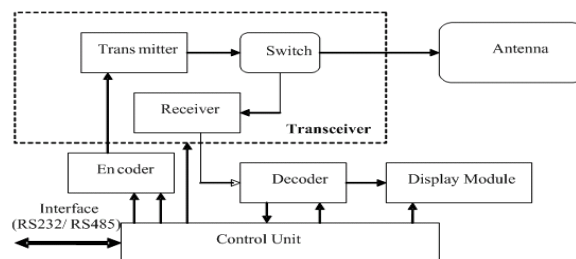


Figure A3

- A4. Which one of the following options is an RFID application used to prevent theft in libraries?
- (a) Electronic Article Surveillance (EAS)
 - (b) Electronic Artificial Surveillance (EAS)
 - (c) Electronic Artificial Intelligence (EAI)
 - (d) Electronic Identical Intelligence (EII)
- A5. Which one of the following options is the advantage of IEEE802.11a compared to IEEE802.11g?
- (a) fewer non-overlapping frequency channels and less interference
 - (b) more non-overlapping frequency channels and less interference
 - (c) fewer non-overlapping frequency channels and wider coverage
 - (d) more non-overlapping frequency channels and wider coverage
- A6. Which one of the following statements about the ZigBee technology is **TRUE**?
- (a) It is suitable to use for transferring of videos or images between two ZigBee devices.
 - (b) There are three types of logical devices in ZigBee technology.
 - (c) End device is a logical device where one and only one is required for each ZigBee Network.
 - (d) There are 16 frequency channels in ZigBee technology.
- A7. Which one of the following options is the most suitable answer for Bluetooth classic?
- (a) 2.4 GHz ISM band and 79 channels
 - (b) 5.2 GHz ISM band and 40 channels
 - (c) 2.4 GHz ISM band and 40 channels
 - (d) 2.4 GHz ISM band and 30 channels
- A8. Which one of the following options is the main advantage of using more cells per cluster compared to fewer cells per cluster in cellular systems?
- (a) Low system capacity
 - (b) High system capacity
 - (c) More co-channel interference
 - (d) Less co-channel interference

- A9. Which one of the following characteristics is implemented in the MAC layer for WiMAX technology?
- (a) Adaptive modulation
 - (b) Adaptive burst profile
 - (c) QoS requirement
 - (d) Encryption
- A10. When building a Wireless Infrastructure for Business, which one of the following steps requires the organization to send out a request for information (RFI) to vendors?
- (a) Collection of information for new wireless infrastructure
 - (b) Conducting wireless site survey
 - (c) Perform a limited trial
 - (d) Request for proposal (RFP)

SECTION B [80 Marks]

- B1. Figure B1 shows the signal waveform with the binary bit pattern $(101001101)_b$ which was transmitted from an RFID tag to the reader in an RFID Item Management system. The RF carrier frequency used in this system is 868 MHz.

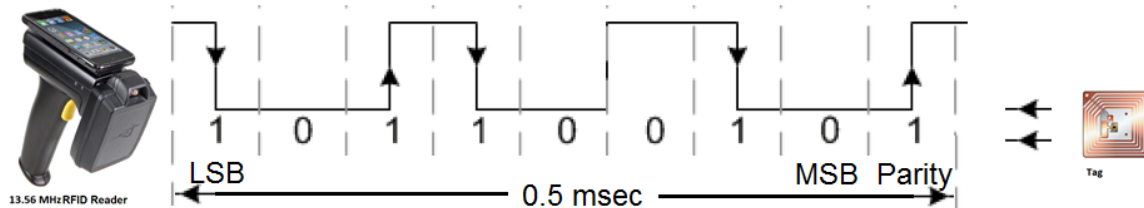


Figure B1

- (a) State the type of signal coding methods used in the signal waveform shown in Figure B1. (1 mark)
- (b) If the read range between the reader and tag is 2 m, determine whether the far field or near field mechanism was used in this system. You may use $d = \frac{\lambda}{2\pi}$ to determine the mechanism, where λ is 0.35m which is the free space wavelength of the RF carrier. (2 marks)
- (c) Which type of parity error detection method was used in this system? (1 mark)
- (d) Determine the bit rate of the data in bits per second (bps). (2 marks)
- (e) What is the frequency band used in the system and what is the typical maximum reading range of this frequency band? (2 marks)
- (f) Describe the one advantage for using the above frequency band compared to other frequency bands. (1 mark)
- (g) State the main difference between the passive tag and the semi-passive tag. (1 mark)

- B2. Figure B2 shows the available frequency channels in one of the WLAN IEEE 802.11 standard.

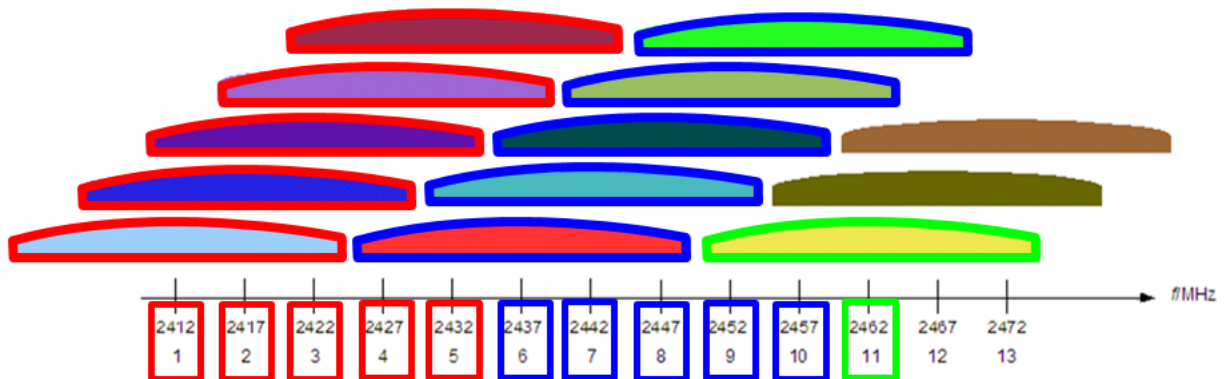


Figure B2

- What is the frequency band for this WLAN IEEE 802.11 standard? (1 mark)
- What is the maximum number of non-overlapping frequency channels available for the above IEEE 802.11 standard? (1 mark)
- If the WLAN IEEE 802.11 standard in Figure B2 has maximum bit rate of 54 Mbps, what is this standard? (1 mark)
- What is the channel bandwidth of the WLAN IEEE 802.11 standard in Figure B2? (1 mark)
- What is the frequency of channel no. 6 in the WLAN IEEE 802.11 standard? (1 mark)
- Name one advantage and one disadvantage of using this frequency band compared to 5.8 GHz ISM band in WLAN IEEE 802.11 standard. (2 marks)
- Determine the bitrate for the WLAN IEEE 802.11a if the modulation is **QPSK** and the convolution coding rate is $\frac{3}{4}$. The following equation can be used to find the bitrate.

$$\text{Bitrate} = 0.25 \times R \times 48 \times \log_2 M, \text{ Mbps}$$
 (2 marks)
- There are **nine** logical services in the WLAN 802.11 standard. Which logical service routes frames from a wired LAN to a STA in a BSS? (1 mark)

- B3. Figure B3 shows one of the ZigBee wireless applications used for a home automation system that provides control and monitoring using ZigBee enabled lights, switches and sensors.



Figure B3

- (a) What is the IEEE 802 standard that specifies the physical layer and media access control for ZigBee technology? (1 mark)
- (b) Which layer defines the radio frequency channels and modulation techniques in the ZigBee wireless technology? (1 mark)
- (c) There are three network topologies in the ZigBee technology. Name the network topology used in Figure B3. (1 mark)
- (d) There are two types of **hardware devices** in the ZigBee technology. Which hardware device should be used at “Light” in Figure B3? (1 mark)
- (e) There are three types of **logical devices** in the ZigBee technology. Which logical device should be used at “Motion sensor” in Figure B3? (1 mark)
- (f) Which device is used as a coordinator in Figure B3? (1 mark)
- (g) Two modulation techniques such as BPSK, O-QPSK are used in ZigBee technology. Which modulation technique is used to provide the maximum bitrate of 250 kbps for ZigBee? (1 mark)
- (h) Which physical layer protocol is used in ZigBee technology? (1 mark)
- (i) State the two advantages of using ZigBee technology for monitoring and controlling applications. (2 marks)

- B4. Figures B4.1 and B4.2 show one of the network topologies used in Bluetooth technology and the Bluetooth protocol stack respectively.

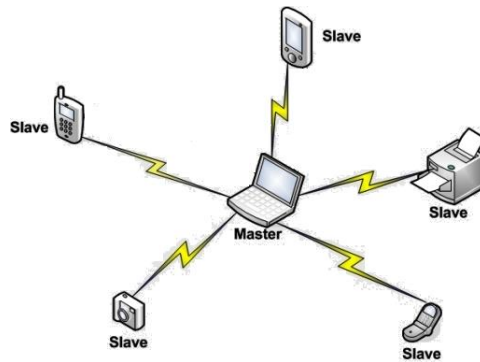


Figure B4.1

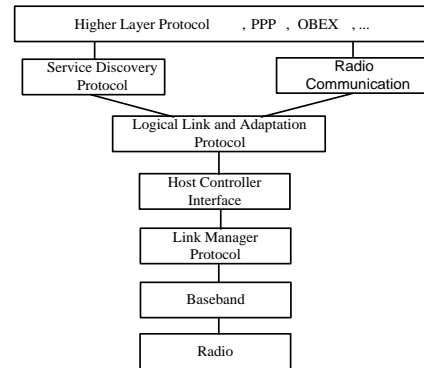
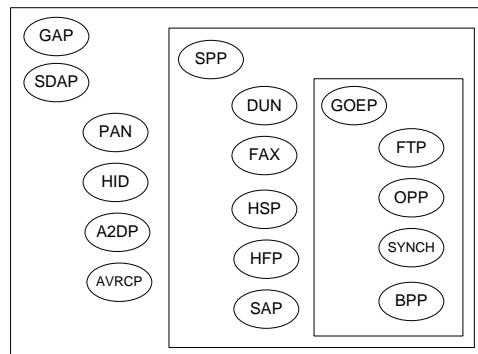


Figure 4.2

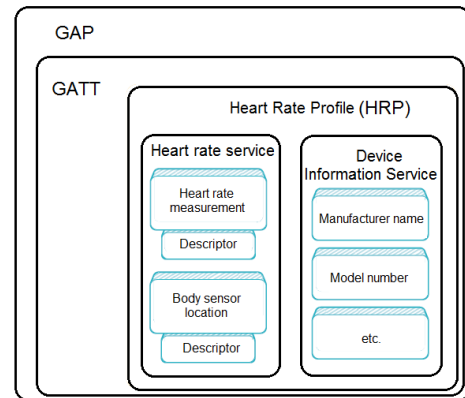
- (a) What is the IEEE 802 standard for Bluetooth technology? (1 mark)
- (b) Name the network topology given in Figure B4.1 for the Bluetooth technology? (1 mark)
- (c) What is the maximum number of links **for data** in Bluetooth that a master device can support? (1 mark)
- (d) What is the maximum number of slaves that a master device can connect by using voice link? (1 mark)
- (e) Which type of the physical links was used among the Bluetooth master device and slaves in Figure B4.1? (1 mark)
- (f) Which layer in Figure B4.2 manages physical channels and links, handles packets and does paging and inquiry to locate other Bluetooth devices in the area? (1 mark)
- (g) Which layer in Figure B4.2 provides the interface between the lower layer of Bluetooth and the upper layer of Bluetooth which are separately implemented using two different processors? (1 mark)
- (h) Which layer in Figure B4.2 provides serial port emulation for Bluetooth computer's standard serial port? (1 mark)
- (i) Which layer in Figure B4.2 is responsible for segmenting and reassembling data packets? (1 mark)
- (j) Which layer in Figure B4.2 is responsible for performing security and error correction? (1 mark)

B5. Figure B5.1 and Figure B5.2 show the relationship among Bluetooth profiles for Bluetooth Classic and the Heart Rate Profile for Bluetooth Low Energy respectively.



Relationship among Bluetooth Profiles

Figure B5.1



BLE Heart Rate Profile

Figure B5.2

- (a) Which of the two profiles in Figure B5.1 are the most basic Bluetooth profiles for Bluetooth Classic? (2 marks)
- (b) From Figure B5.1, list all the required Bluetooth foundation profiles to transfer files or images between two Bluetooth-enabled devices? (2 marks)
- (c) Which Bluetooth profile is used to synchronize data between a Smart phone and a laptop in Figure B5.1? (1 mark)
- (d) Which Bluetooth profile is used to connect a Bluetooth keyboard and mouse to a laptop in Figure B5.1? (1 mark)
- (e) Which Bluetooth profile allows Bluetooth headsets and car hands-free kits to communicate with Bluetooth mobile phones in Figure 5.1? (1 mark)
- (f) Which one of the profiles in Figure B5.2 is the most basic Bluetooth profile for Bluetooth Low Energy apart from GAP? (1 mark)
- (g) What are the two **service level declaration** attributes for the heart rate application in Figure B5.2? (2 marks)

B6. Figure B6 shows the network architecture of the WiMAX technology.

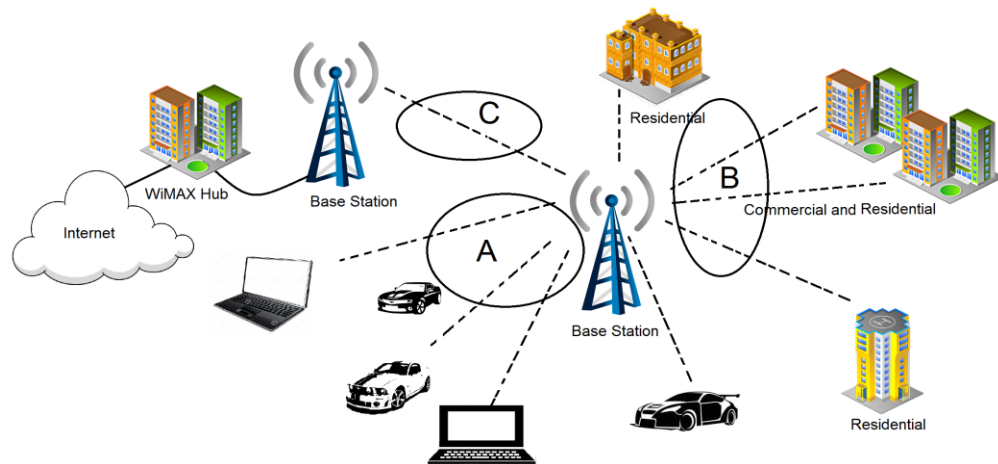


Figure B6

- (a) What is the maximum throughput in Mbits/s for the WiMAX technology?
(1 mark)
- (b) Name the three IEEE WiMAX standards with **their respective label (A, B & C)** shown in Figure B6.
(3 marks)
- (c) What is the frequency range of the WiMAX standards that requires non-line-of-sight (NLOS) operation for point-to-multipoint communication for stationary users?
(1 mark)
- (d) Name one similar characteristic between the WirelessMAN-SC and WirelessMAN-SCa physical layer implementations?
(1 mark)
- (e) Which feature in the Physical layer is to enable WiMAX to operate over the widest selection of frequency bands around the world?
(1 mark)
- (f) Which feature of WiMAX is to minimize the interference between the WiMAX stations?
(1 mark)
- (g) Which relevant layer performs the authentication of a legitimate user in WiMAX network?
(1 mark)
- (h) Which one of the MAC sublayers is able to provide low latency for delay sensitive services and optimal transport for video, data prioritization?
(1 mark)

- B7. Figures B7.1 and B7.2 show the cellular network diagram showing three clusters and the architecture of 3G UMTS (Universal Mobile Telecommunications System).

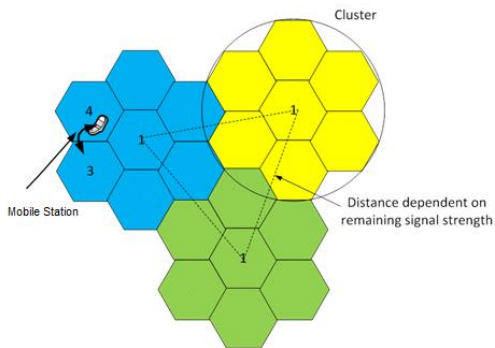


Figure B7.1

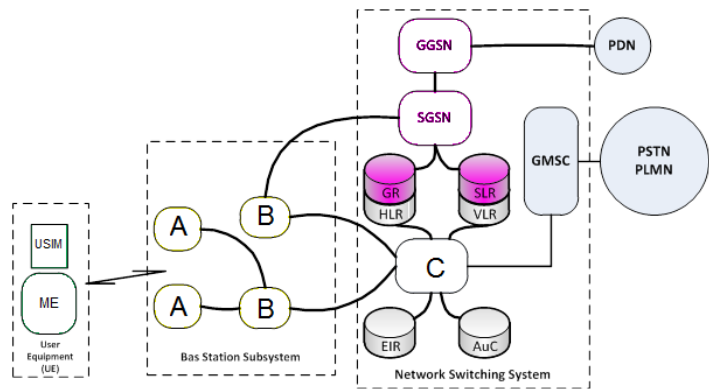


Figure B7.2

- (a) What is the size of one cluster in Figure B7.1? Give the answer in no. of cells per cluster? (1 mark)
- (b) If a mobile user is changed from one cell to another during a phone call, the connection will be passed to the neighbour cell as shown in Figure B7.1, what is the term used to describe this process? (1 mark)
- (c) Name the block A in the above 3G UMTS system in Figure B7.2 and describe one of its main functions. (2 marks)
- (d) Name the block B in the above 3G UMTS system in Figure B7.2 and describe one of its functions. (2 marks)
- (e) Name the block C in the above 3G UMTS system in Figure B7.2 and describe one of its main functions. (2 marks)
- (f) What is the main difference between the Home Location Register (HLR) and Visitor Location Register (VLR)? (1 mark)
- (g) Which functional block in UMTS is responsible for encryption of communications between mobiles users? (1 mark)

- B8. There is a need to set up a smart locker system using wireless technologies for an educational institution consisting of more than 300 lockers for more than ten thousand users as part of a smart storage application. Figure B8 shows the **sample** architecture of the **proposed system**.

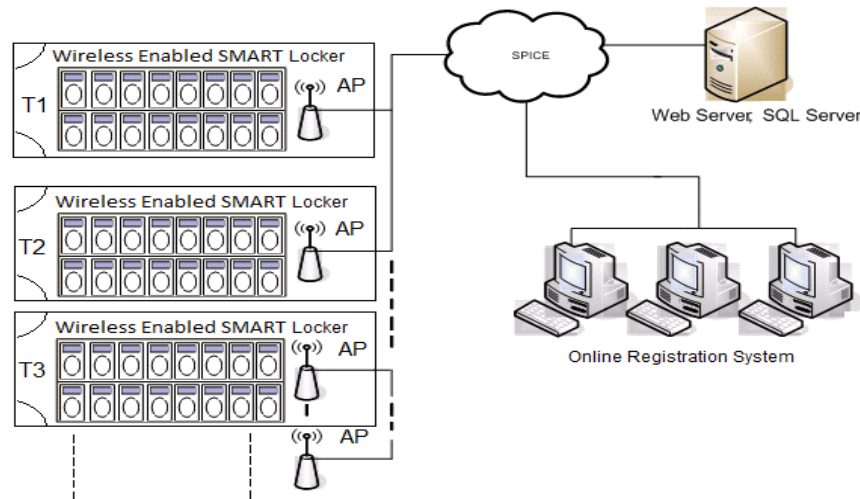


Figure B8

- (a) Name two of the wireless technologies that are required to be used in this proposed system to track the equipment on the shelf and send information to the backend as well. (2 marks)
- (b) After the assessment of existing network infrastructure, what is the next step required to determine suitable wireless technologies for the current business strategy? (1 mark)
- (c) When should the wireless site survey be done in order to set up a wireless infrastructure for the organization? (1 mark)
- (d) **Different applications** often have different network requirements. What should be the major network requirement for the wireless system to provide the real time storage system? (1 mark)
- (e) Name three different types of people who are suitable to perform the wireless site survey. (3 marks)
- (f) In ROI measurement for determining costs, it is important to consider all costs involved. Name the two types of costs involved in ROI calculation. (2 marks)

***** END OF PAPER *****