

**2016/2017 SEMESTER ONE EXAMINATION**

Diploma in Engineering with Business  
3<sup>rd</sup> Year Full Time

**WIRELESS TECHNOLOGY APPLICATIONS**

Time Allowed: 2.0 Hours

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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.

1. Which one of the following wireless technologies is under the **WPAN** and is suitable for an activity tracker application using smart phones and wearable devices?
  - (a) ZigBee
  - (b) UWB
  - (c) Bluetooth Low Energy (BLE)
  - (d) Bluetooth Classic
2. Which one of the multiple access techniques requires a predetermined or reserved time slot for each user to differentiate among multiple transmissions using the same frequency?
  - (a) TDMA
  - (b) FDMA
  - (c) CDMA
  - (d) CSMA
3. Figure A3 shows the three data bytes (56, 34 & 12)<sub>hex</sub> and the LRC byte (70)<sub>hex</sub> received by an RFID transponder. For error free received data, what are the values of X, Y and Z?
  - (a) X = (62)<sub>hex</sub>, Y = (74)<sub>hex</sub> and Z = (E4)<sub>hex</sub>
  - (b) X = (62)<sub>hex</sub>, Y = (70)<sub>hex</sub> and Z = (00)<sub>hex</sub>
  - (c) X = (90)<sub>hex</sub>, Y = (74)<sub>hex</sub> and Z = (04)<sub>hex</sub>
  - (d) X = (90)<sub>hex</sub>, Y = (70)<sub>hex</sub> and Z = (00)<sub>hex</sub>

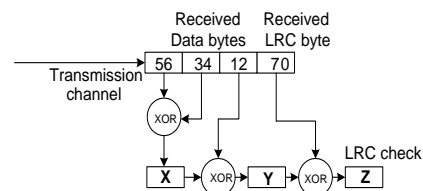


Figure A3

4. Which one of the following options is one of the features in RFID technology that enables it to retrieve a selected RFID tag among the same type of RFID tags?
  - (a) anti-collision
  - (b) data collision
  - (c) error detection
  - (d) signal modification by an authorized user

5. Which one of the following services is used to enable data encryption between different STAs in IEEE 802.11 standard?
  - (a) De-authentication
  - (b) Association
  - (c) Privacy
  - (d) Authentication
  
6. Which one of the following applications is the most suitable application for using the ZigBee technology?
  - (a) Web browsing
  - (b) Transfer of images
  - (c) Streaming of video
  - (d) Monitoring of temperatures and humidity of surroundings
  
7. Which one of the following options is the most suitable answer for Bluetooth low energy (BLE)?
  - (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
  
8. Which one of the following is the air interface used in Universal Mobile Telecommunications System (UMTS) for 3G?
  - (a) WCDMA
  - (b) TDMA
  - (c) FDMA
  - (d) TDMA/FDMA
  
9. Which one of the physical layer implementations in the IEEE 802.16 WiMAX standard does **not require a line of sight (LOS)** for point-to-point connection?
  - (a) WirelessMAN- Single Carrier (SC)
  - (b) WirelessMAN-Single Carrier Amendment (SCa)
  - (c) WirelessMAN- Orthogonal Frequency Division Multiplexing (OFDM)
  - (d) WirelessMAN- Orthogonal Frequency Division Multiple Access (OFDMA)

10. In building a Wireless Infrastructure for Business, wireless site survey should be performed by which one of the following people?
- (a) CTO of the company
  - (b) Purchasing staff of the company
  - (c) Stakeholders of the company
  - (d) Technical staff of the company

## SECTION B [ 80 Marks ]

- B1. Figure B1.1 shows the basic RFID system consisting of a handheld reader and a tag. Figure B1.2 shows the partially completed block diagram of an RFID reader.



Figure B1.1

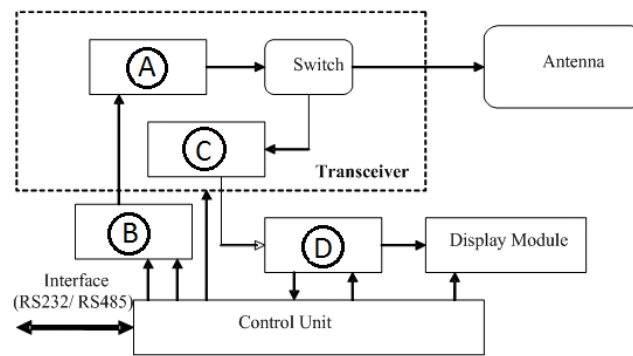


Figure B1.2

- (a) Name the frequency band of 13.56 MHz which is used in this system. (1 mark)
- (b) If the read range between the reader and tag is 0.1 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  $\lambda$  is 22m which is the free space wavelength of the RF carrier. (2 marks)
- (c) Determine all the labels (A) to (D) in Figure B1.2 using the list of possible words found in Table B1.

| List of possible words |          |            |            |
|------------------------|----------|------------|------------|
| Transmitter            | Receiver | Multiplier | Processor  |
| Encoder                | Decoder  | Encryption | Decryption |

Table B1

- (d) List two advantages of a passive RFID compared to an active RFID. (4 marks)
- (e) Name one of the RFID applications using the above frequency band. (2 marks)
- (1 mark)

- B2. Figure B2.1 and B2.2 show the two basic modes of operation for IEEE 802.11 WLAN used for wireless communications.

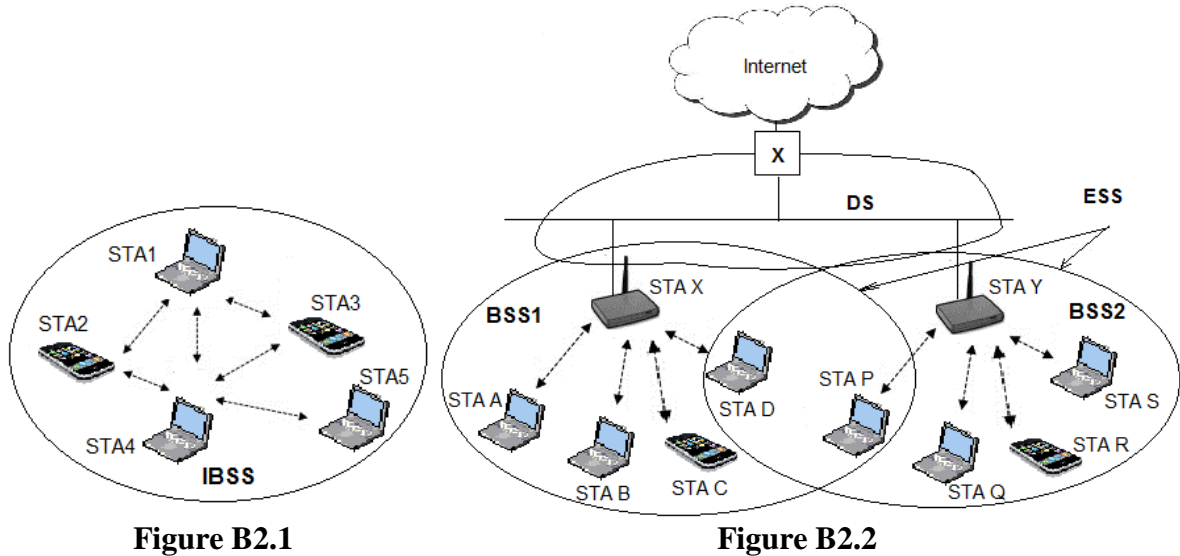


Figure B2.1

Figure B2.2

- Which figure shows the ad-hoc WLAN network? Give the answer with a suitable reason. (2 marks)
- How many frequency channels are available for IEEE 802.11a standard? (1 mark)
- Name one of the licence-free frequency bands used in IEEE 802.11a standard? (1 mark)
- There are 4 different types of ESS configurations possible; namely *partially overlap BSSs*, *physically disjoint BSSs*, *physically co-located BSSs* and *co-existence of other IBSS or ESS networks*. What ESS configuration is represented by BSS1 and BSS2? (1 mark)
- There are four distribution services and five station services required for wireless LAN operation. Name any two distribution services implemented in the IEEE 802.11 logical services. (2 marks)
- In Figure B2.2, STA C subsequently moves from BSS1 into BSS2 and it becomes out of the range of STA X, the AP of BSS1. Which DS logical service is required for it to join BSS2? (1 mark)
- Which one of the station services is used to enable data encryption among different STAs in IEEE 802.11 standard? (1 mark)
- If the email and web browsing applications are required to be implemented, which mode of operation is required? (1 mark)

- B3. The protocol stack of the ZigBee technology is illustrated in Figure B3.1. Figure B3.2 shows one of the ZigBee wireless applications used for a typical home heating system that provides control for the heating/air-conditioning thermostats through switches.

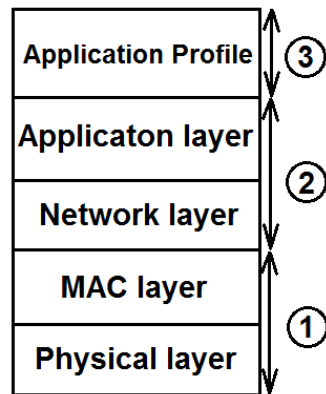


Figure B3.1

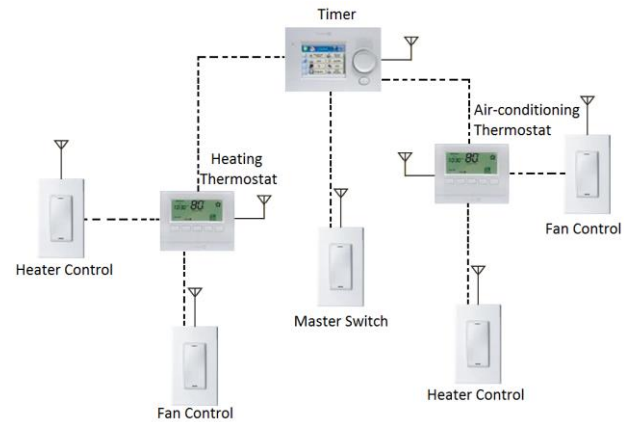


Figure B3.2

- (a) Which one of the IEEE 802 standards 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) Name the organization/promoter who builds on IEEE 802 standard and defines the network and application layers in the ZigBee wireless technology. (1 mark)
- (d) There are three operating frequency bands which are 868 MHz, 915 MHz, and 2.4 GHz in ZigBee. What are the maximum bit rates supported by these frequency bands? (3 marks)
- (e) There are three network topologies in the ZigBee technology. Name the network topology used in Figure B3.2. (1 mark)
- (f) There are two types of **hardware devices** in the ZigBee technology. Which hardware device should be used at “Heating Thermostat or Air-conditioning Thermostat” in Figure B3.2? (1 mark)
- (g) There are three types of **logical devices** in the ZigBee technology. Which logical device should be used at “Heater Control or Fan Control or Master Switch” in Figure B3.2. (1 mark)
- (h) Which device is used as a coordinator in Figure B3.2? (1 mark)

- B4. Figures B4 shows the timing diagram of transmitted packets among a master Bluetooth device and two Bluetooth slaves.

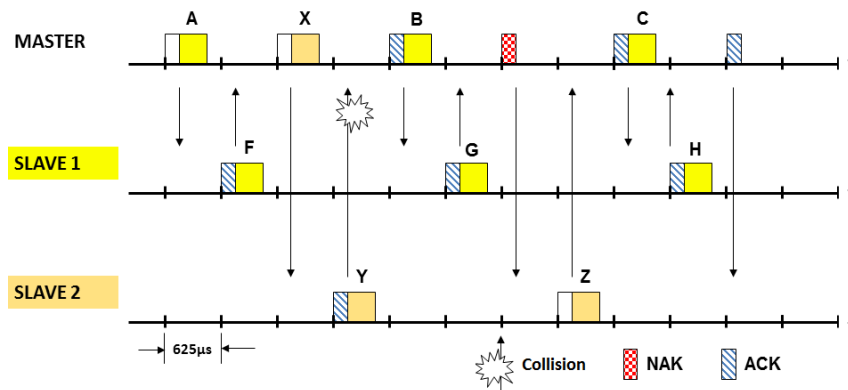


Figure B4

- Which duplexing technique is used in Bluetooth? (1 mark)
- Which of the Bluetooth network topologies is described in Figure B4? (1 mark)
- What is the packet size (in number of slots) used in the above Bluetooth transmission? (1 mark)
- Bluetooth uses frequency hopping spread spectrum (FHSS) to transmit data by using different frequencies for different packets. What is the frequency hopping rate (hops/sec) used in Figure B4? (1 mark)
- Which type of the physical links was used between the Bluetooth master device and slave 1 in Figure B4? Give your answer with a suitable reason. (2 marks)
- Name the **retransmitted packet sent from slave 2** to the master Bluetooth device during the above transmission due to collision. (1 mark)
- Name one type of the physical links used to transfer **data** between one Bluetooth device to another Bluetooth device. (1 mark)
- Name one type of the physical links used to transfer stereo music from an MP3 player to a Bluetooth stereo headset. (1 mark)
- What is the maximum number of slaves that a master device can connect by using data link? (1 mark)



- B5. Figure B5.1 and Figure B5.2 show the Bluetooth frame with the details of **packet header** for the Bluetooth technology and all the possible states of the Bluetooth link controller for Bluetooth connection respectively.

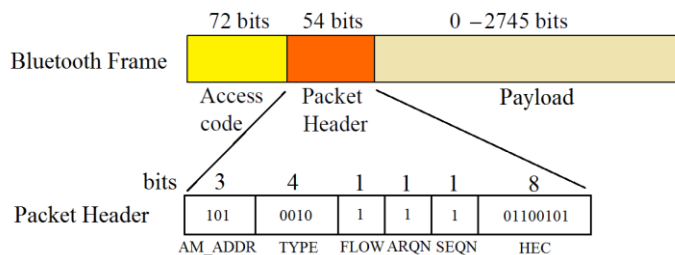


Figure B5.1

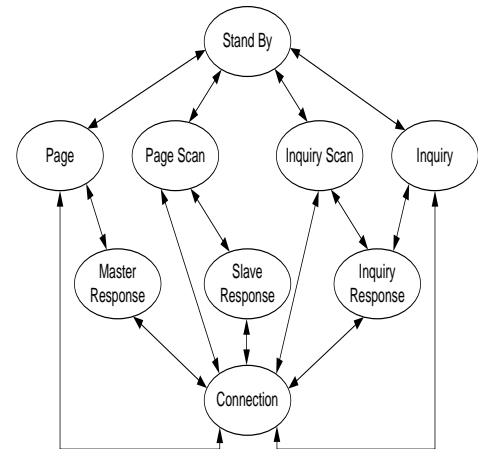
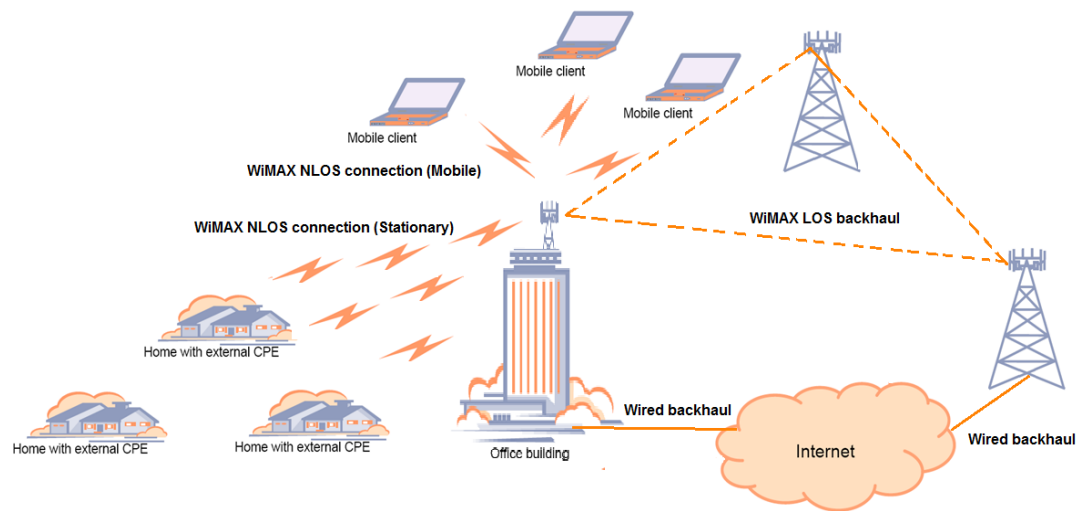


Figure B5.2

- Name one of the important data contained in Bluetooth Access code. (1 mark)
- What is the size (in number of bits) of the actual data that is transmitted in the packet header in Figure B5.1? What is the reason for transmitting it three times? (2 marks)
- Which data field in the **packet header** determines the last packet that has been received with or without errors? (1 mark)
- Which data field in the **packet header** determines if the packet is the new packet or retransmitted packet? (1 mark)
- Which data field in the **packet header** determines the maximum number of active slaves possible in a piconet? (1 mark)
- What is the state of the Bluetooth-enabled device if it is not connected to any other devices? (1 mark)
- What is the state of the Bluetooth-enabled device when it is connected to a piconet as a master or slave? (1 mark)
- What is one of the Bluetooth connection procedures that enables a Bluetooth device to discover any Bluetooth-enabled devices around its vicinities? (1 mark)
- Name one of the applications for Bluetooth using File Transfer Profile (FTP)? (1 mark)

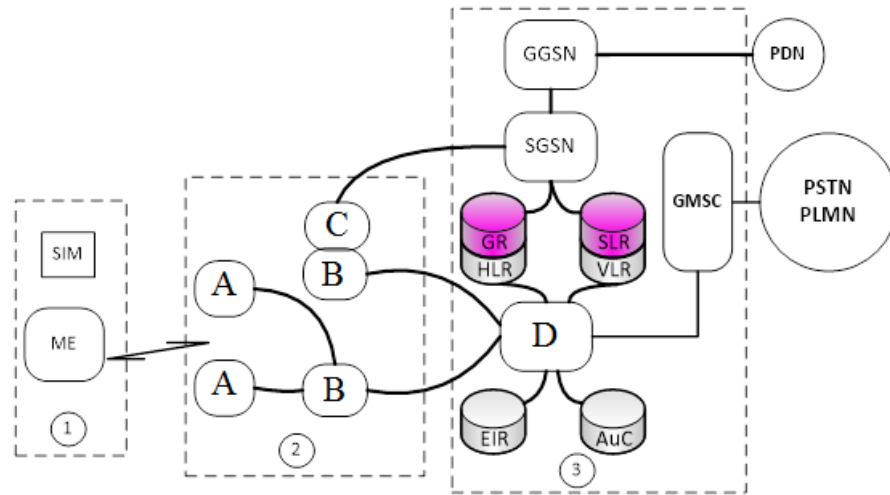
B6. Figure B6 shows the network architecture of the WiMAX technology.



**Figure B6**

- (a) Which multiple access technique is used in WiMAX? (1 mark)
- (b) Which WiMAX standard is used to extend the broadband services for mobile users in Hot spots? (1 mark)
- (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) What are the two characteristics that are different between the WirelessMAN-SC and WirelessMAN-SCa physical layer implementations? (2 marks)
- (e) Which feature in the Physical layer is to enable widest selection of frequency bands to operate WiMAX around the world? (1 mark)
- (f) Which feature in the Physical layer is to have the widest choice of frequency band selection depending on the channel condition? (1 mark)
- (g) Which feature in the Physical layer is used to suppress interference and increase system gain of the WiMAX deployment? (1 mark)
- (h) Which feature in the Physical layer is to minimize the interference between the WiMAX stations? (1 mark)
- (i) Which MAC sublayer of WiMAX supports a variety of backhaul requirements including ATM, Ethernet, IPv4, IPv6 and VLAN? (1 mark)

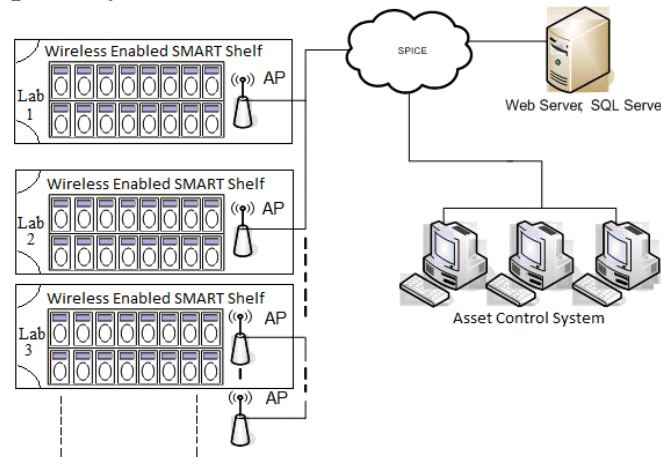
B7. Figures B7 shows the three main sections of 2.5G, “GPRS” architecture.



**Figure B7**

- What is the name of sub-section two, “②” for “GPRS” architecture as shown in Figure B7?  
(1 mark)
- What is the name sub-section three, “③” in “GPRS” architecture as shown in Figure B7?  
(1 mark)
- Name the block A in the above “GPRS” system and describe one of its main functions.  
(2 marks)
- Name the block B in the above “GPRS” system and describe one of its functions.  
(2 marks)
- Name the block C in the above “GPRS” system and describe one of its main functions.  
(2 marks)
- Name the block D in the above “GPRS” system and describe one of its main functions.  
(2 marks)

- B8. There is a need to setup an asset tracking system using wireless technologies for an educational institution with more than 300 laboratories and more than 40,000 equipment to provide a smart application for efficient inventory control and tracking. 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 organisational assessment and the current **manual inventory taking** system have been evaluated and it is determined that wireless technologies can fit into the current business strategy. What will be the next step to set up this wireless infrastructure? (1 mark)
- (c) When should the wireless site survey be done 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 track the assets in real time? (1 mark)
- (e) If the current IT staff in the institution face challenges to select different wireless technologies, who are the right people to get help? What type of documents are to be sent to them for their advices? (3 marks)
- (f) Which type of important tables should be included in the request for proposal (RFP)? (1 mark)
- (g) State one of possible training to provide all users as well as support specialists with the knowledge to effectively operate the system. (1 mark)

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