SINGAPORE POLYTECHNIC   **ET1205**

2019/2020 SEMESTER TWO EXAMINATION

Diploma in Engineering with Business
Diploma in Computer Engineering
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 suitable for the transferring of images/messages between two smartphones using WhatsApp application when the WiFi hot spots and networks are **not available**?

   (a)   ZigBee
   (b)   Wireless LAN IEEE802.11
   (c)   Radio Frequency Identification
   (d)   Wireless Wide Area Network: 3G or 4G

A2. Which one of the following frequency bands has a low signal attenuation and is least susceptible to liquids or metals?

   (a)   Low Frequency (LF)
   (b)   Very High Frequency (VHF)
   (c)   Ultra High Frequency (UHF)
   (d)   High Frequency (HF)

A3. Which one of the following options is an error detection code used in RFID technology which requires a generator polynomial?

   (a)   Parity
   (b)   Longitudinal Redundancy Check (LRC)
   (c)   Cyclic Redundancy Check (CRC)
   (d)   Pulse Pause Coding (PPC)

A4. Which one of the following options is an example of the RFID applications used to monitor and prevent the unauthorized sign out of books in a library?

   (a)   Emergency Asset Searching System
   (b)   Electronic Asset Servicing System
   (c)   Electronic Article Surveillance System
   (d)   Electrical Artificial Surveillance System

A5. Which one of the following entities integrates wired and wireless connection to provide internet access for the users in WLAN IEEE802.11 systems?

    (a)   DS and ESS
    (b)   AP and STA
    (c)   BSS and ESS
    (d)   Portal

A6. Which one of the following applications is the most suitable application for using the ZigBee technology?

    (a)   Monitoring of temperatures and humidity of environments
    (b)   Transfer of images
    (c)   Streaming of video
    (d)   Web browsing

A7. Which one of the following features in Bluetooth reduces the effects of interference between Bluetooth and other wireless technologies such as WLAN and ZigBee?

    (a)   Adaptive battery control
    (b)   Adaptive frequency hopping
    (c)   Adaptive bust profile
    (d)   Adaptive modulation

A8. Which one of the following is used in LTE Downlink Transmission Scheme?

    (a)   OFDMA
    (b)   SC-FDMA
    (c)   DSSS
    (d)   AFHSS

A9. Which one of the following characteristics is the most important for IoT sensor networks in 5G?

    (a)   Very high data rate
    (b)   Mobility
    (c)   Support massive number of devices
    (d)   Larger power usages

A10. Which group of people is the most important group in an organization that should be involved in making the investment in wireless technology?

    (a)   The organization's IT team
    (b)   External consultants
    (c)   The big IT vendor
    (d)   Manufacturer for wireless products

***** END OF SECTION A ******

SECTION B [80 Marks]

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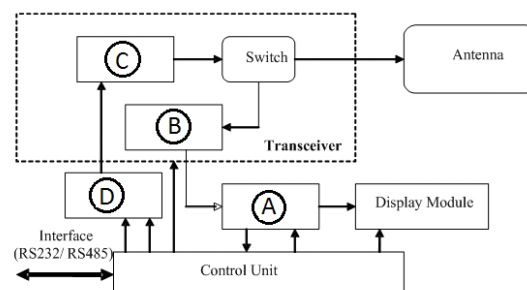
**Figure B1.1**   **Figure B1.2**

(a)   Name the frequency band for 860 MHz - 960 MHz which is used in this system.

(1 mark)

(b)   If the read range between the reader and tag is 3 m, determine whether far field or near field mechanism was used in this system. You may use

$d = \dfrac{\lambda}{2\pi}$ to determine the mechanism, where λ is 35 cm 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

(4 marks)

(d)   List two advantages of a passive RFID compared to an active RFID.

(2 marks)

(e)   If LF, HF, UHF and SHF frequency bands are available for the RFID technology, which one of these frequency bands is suitable for the animal identification?

(1 mark)

B2.   Figure B2 shows the infrastructure mode for IEEE 802.11 WLAN standard.
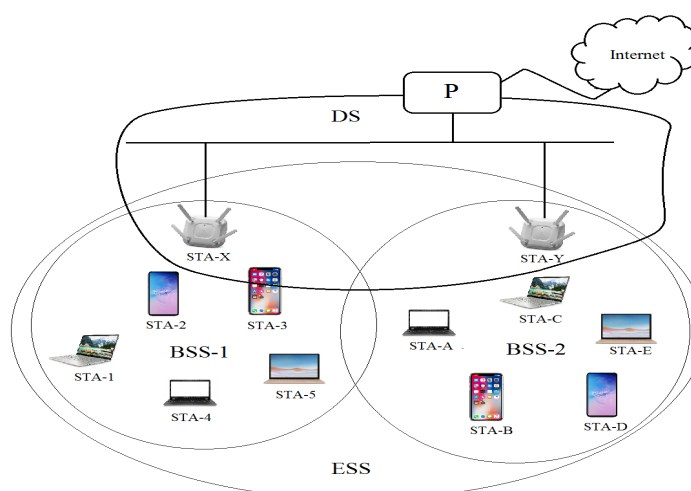
Figure B2

(a)   How many frequency channels are available for WLAN IEEE 802.11a standard?

(1 mark)

(b)   What is the ISM frequency band used in WLAN IEEE 802.11g standard?

(1 mark)

(c)   What is the mode of operation for IEEE 802.11 for Wireless LAN in Figure B2?

(1 mark)

(d)   Among IEEE 802.11a, IEEE 802.11b and IEEE 802.11g, which one can provide higher bit rate and better coverage?

(1 mark)

(e)   Which entity found in Figure B2 is a collection of devices that can transmit and receive to one another within the RF transmission range?

(1 mark)

(f)   Which two stations or Access Points (APs) join the BSS to the DS in Figure B2?

(1 mark)

(g)   In Figure B2, what is the station service used by all STAs to establish their identity to APs with which they will communicate?

(1 mark)

(h)   What ESS configuration is represented by BSS-1 and BSS-2?

(1 mark)

(i)   If the STA-A moves from BSS-2 to BSS-1 in Figure B2, which logical service is required to associate with the new AP?

(1 mark)

(j)   In Figure B2, what is the functional block "**P**"?

(1 mark)

B3.   The protocol stack of the ZigBee technology is illustrated in Figure B3.1. Figure B3.2 shows the routing of frames/messages when a designated device comes and joins into a ZigBee network with a cluster head.
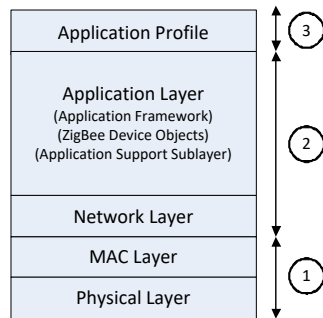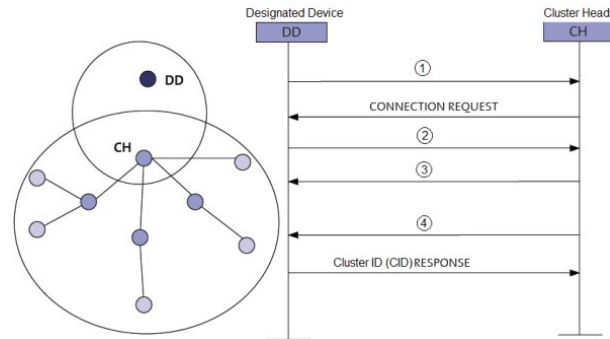

Figure B3.1   **Figure B3.2**

(a)   Which one of the ZigBee protocol layers shown in Figure B3.1 defines the frequency channels and modulation techniques?

(1 mark)

(b)   Which layer defines the channel access mechanism called CSMA/CA in the ZigBee wireless technology?

(1 mark)

(c)   What is the maximum bit rate of the ZigBee technology operating in the 2.4 GHz frequency band?

(1 mark)

(d)   Which one of the ZigBee protocol layers is represented by the diagram shown in Figure B3.2?

(1 mark)

(e)   There are two types of **hardware devices** in the ZigBee technology. Name the device which is low power, low cost and battery powered?

(1 mark)

(f)   In Figure B3.2, which one is the coordinator: Device CH or Device DD?

(1 mark)

(g)   What is the packet ③ in Figure B3.2?

(1 mark)

(h)   What is the packet ④ in Figure B3.2?

(1 mark)

(i)   There are three network topologies in the ZigBee technology. Name the network topology shown in Figure B3.2?

(1 mark)

(j)   There are three types of **logical devices** in the ZigBee technology. Name the device that participates in multi-hop routing of messages in a ZigBee network?

(1 mark)

B4.   Figures B4.1 shows the timing diagram of transmitted packets among a master Bluetooth device and two Bluetooth slaves. Figure B4.2 shows the relationship among Bluetooth profiles used in Bluetooth Classic.
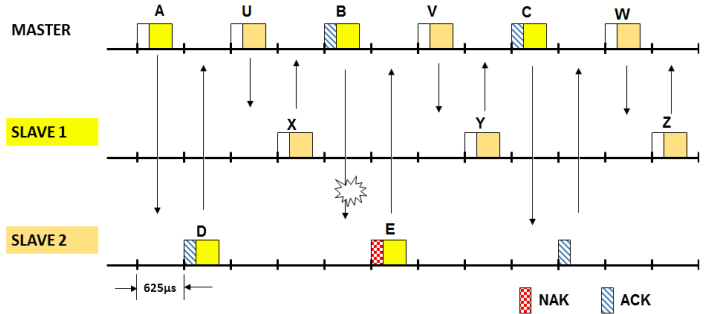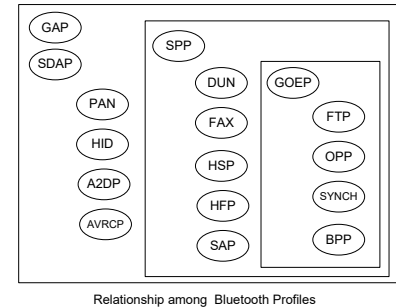

<div align="center">

Figure B4.1   **Figure B4.2**

</div>

(a)   What is the packet size (in number of slots) used in the above Bluetooth transmission?

(1 mark)

(b)   Time Division Duplex (TDD) is used to provide two way communications in Bluetooth technology. Which time slot is used by the master Bluetooth device?

(1 mark)

(c)   Name the network topology used in Figure B4.1 related to the Bluetooth technology.

(1 mark)

(d)   Reserved time slots were used between the Bluetooth MASTER and SLAVE 1 as shown in Figure B4.1. Which type of the physical links was used between the Bluetooth MASTER and SLAVE 1?

(1 mark)

(e)   What is the maximum number of links **for voice** in Bluetooth that a master device can support?

(1 mark)

(f)   In Figure B4.1, which packet is the retransmitted packet from the Bluetooth MASTER to Bluetooth SLAVE 2?

(1 mark)

(g)   Name the two foundation profiles that is required in a human interface device between two Bluetooth enabled devices in Figure B4.2?

(2 marks)

(h)   Which Bluetooth profile allows Bluetooth headsets and car hands-free kits to communicate with Bluetooth mobile phones in Figure B4.2?

(1 mark)

(i)   Which Bluetooth profile is used to synchronize data between a smart phone and a laptop in Figure B4.2?

(1 mark)

B5.   Figures B5.1 shows all the possible states of the Bluetooth link controller for Bluetooth connection in Bluetooth Classic. Figure B5.2 shows the required profiles and the **service level declaration** attributes for Blood Pressure Profile used in Bluetooth Low Energy.
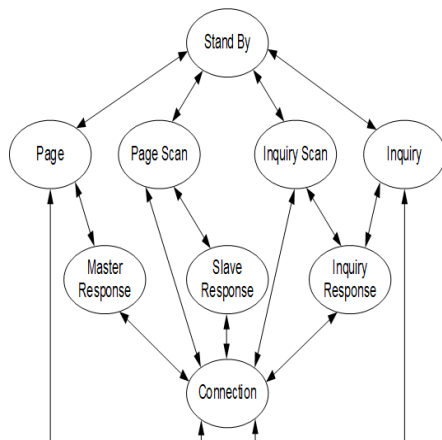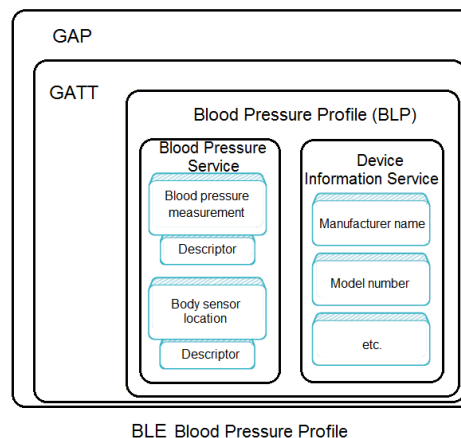

Figure B5.1

Figure B5.2

(a)   In Figure B5.1, if a Bluetooth device needs to discover other Bluetooth-enabled devices within its RF range, what will be the state of the Bluetooth **inquirer**?

(1 mark)

(b)   In Figure B5.1, if a Bluetooth device needs to discover other Bluetooth-enabled devices within its RF range, what will be the state of the Bluetooth **inquiry scanner** which transmits an FHS packet?

(1 mark)

(c)   Name the three procedures that are involved in establishing a connection between a Bluetooth master and a Bluetooth slave.

(3 marks)

(d)   When a Bluetooth device is connected to a master Bluetooth device, name one of the possible modes for the slave that **actively participates** in the piconet.

(1 mark)

(e)   Which one of the profiles in Figure B5.2 is the most basic Bluetooth profile for Bluetooth Low Energy apart from GAP?

(1 mark)

(f)   What are the two **service level declaration** attributes for the blood pressure measurement application in Figure B5.2?

(2 marks)

(g)   How many channels are used in Bluetooth Low Energy?

(1 mark)

B6.   Figures B6.1 and B6.2 show the three main sections of 2.5G, "GPRS" and 3G, "UMTS" architectures respectively.
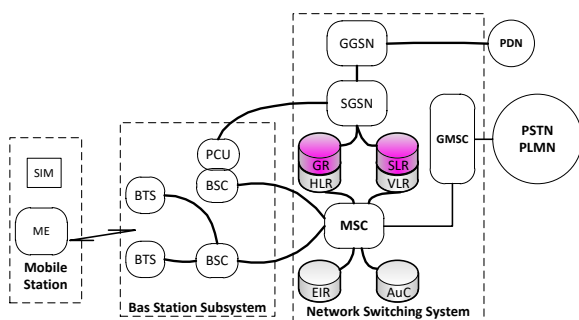

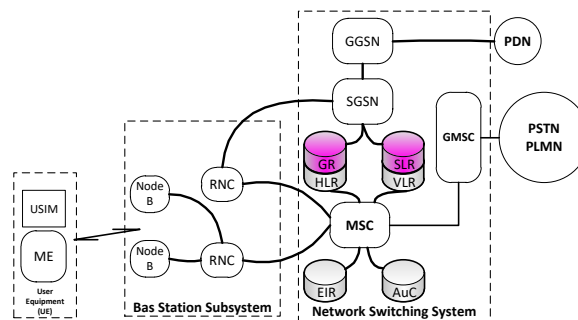**Figure B6.1**   **Figure B6.2**

(a)   By comparing between the two architectures, which of the subsystems are changes required to be made from 2.5G to 3G?

(2 marks)

(b)   Which of the network components in 2.5G is required to be changed to user equipment in 3G?

(1 mark)

(c)   Which of the network components in 2.5G is required to be changed to Node B in 3G?

(1 mark)

(d)   Which of the network components in 2.5G is required to be changed to RNC in 3G?

(1 mark)

(e)   State one of the similarities between the BTS in 2.5G and Node B in 3G.

(1 mark)

(f)   State one of the differences between the BSC in 2.5 G and RNC in 3G.

(1 mark)

(g)   What is the multiple access mode used in 2.5G between MS and BTS?

(1 mark)

(h)   Which functional block in UMTS is responsible for encryption of communications between mobiles users?

(1 mark)

(i)   UMTS system can be implemented using UMTS-FDD or UMTS-TDD. Which UMTS system is required to use only one frequency band for duplex communication?

(1 mark)

B7.   Figure B7.1 shows the three important key areas addressed in 5G wireless access technology. Figure B7.2 shows the 5G network architecture.
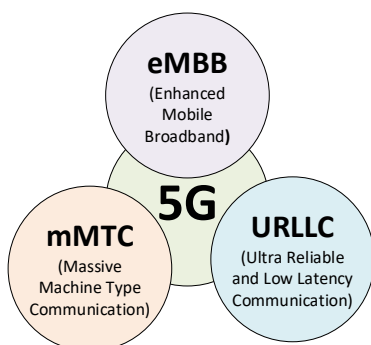

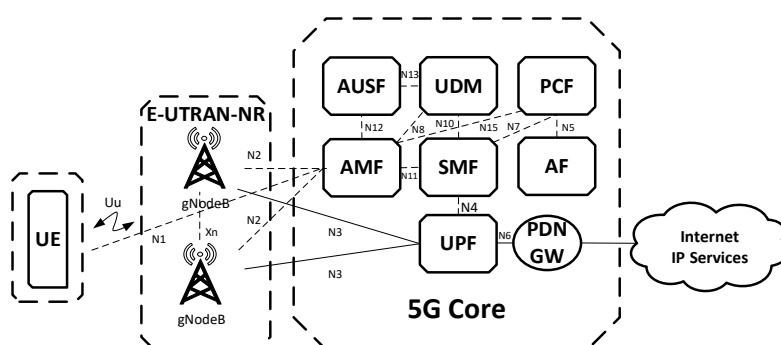**Figure B7.1**   **Figure B7.2**

(a)   State one of the important network requirements for **mobile broadband** users for 5G wireless access technology shown in Figure B7.1.

(1 mark)

(b)   State one of the important network requirements for IoT **sensor** networks for 5G wireless access technology shown in Figure B7.1.

(1 mark)

(c)   State one of the important network requirements for IoT **control** networks for 5G wireless access technology shown in Figure B7.1.

(1 mark)

(d)   State one of the important requirements for dense crowd of user networks for 5G wireless access technology shown in Figure B7.1.

(1 mark)

(e)   Which **one of the physical layer features** in 5G new radio (NR) offers **higher data rates** for **lower frequency** bands (e.g. below 6 GHz frequency)?

(1 mark)

(f)   Which **one of the physical layer features** in 5G new radio (NR) offers **higher transmission ranges** for **high frequency** bands (e.g. mmWave at 26 GHz frequency)?

(1 mark)

(g)   State one of the advantages of using cloud adoption in 5G system.

(1 mark)

(h)   Describe one of the functions performed by AUSF in 5G core.

(1 mark)

(i)   Describe one of the functions supported by UDM in 5G core.

(1 mark)

(j)   Describe one of the functions provided by PCF in 5G core.

(1 mark)

B8.   There is a need to set up **a wireless infrastructure for a connected Smart Factory System of Industry 4.0** to provide smart manufacturing environments for improving output yields and greater operational efficiency. Figure B8 shows the **sample** architecture of the **proposed system**.
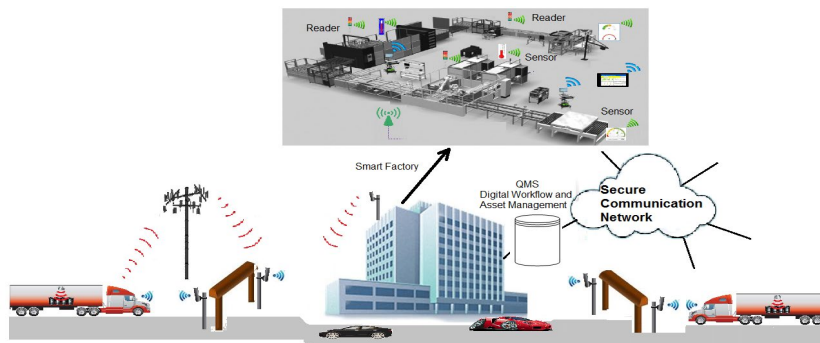
Figure B8

(a)   Name one of the suitable wireless technologies to be used for tracking items to provide the visibility of products which will improve efficiency and quality of the workflow in the smart factory.

(1 mark)

(b)   If real-time locations of items at different locations/regions of connected smart factories to be monitored, name one wireless technology that could be used.

(1 mark)

(c)   **Different industries** often have different network requirements. What should be the major network requirement for the smart factory to implement this wireless system?

(1 mark)

(d)   List any two possible questions that you can ask to find out the information of the present system.

(2 marks)

(e)   Which type of important tables should be included in the request for proposal (RFP)?

(1 mark)

(f)   When should the wireless site survey be done to set up a wireless infrastructure for the organization?

(1 mark)

(g)   If the current IT staff in the institution face challenges to select the right wireless technologies, who are the right people to get help from and what type of documents need be sent to them for their advice?

(2 marks)

(h)   State one possible training to provide all users as well as support specialists with the knowledge to effectively operate the system.

(1 mark)

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