



Strathmore
UNIVERSITY

SCHOOL OF COMPUTING AND ENGINEERING SCIENCES
BACHELOR OF COMPUTER NETWORKS AND CYBER SECURITY
END OF SEMESTER EXAMINATION

CNS3106: WIRELESS NETWORKS

DATE: 3rd August 2023

Time: 10.30-12.30 Hours

Instructions

1. This examination consists of **FIVE** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

QUESTION ONE (30 MARKS-COMPULSARY)

- a) An international company has established its headquarters in Nairobi and three branches in remote locations in Kenya. The branches have to be interconnected through the Internet. Currently, there is no infrastructure in place. The following alternatives are to be considered:
- Cellular network
 - WIMAX
 - Very Small Aperture Terminals (VSATs)
- i. For each alternative, list **two** merits and **two** demerits ; **(8 marks)**
 - ii. With reasons, state the alternative you would choose for this application; **(3 marks)**
 - iii. Sketch the layout of the alternative chosen in (a)(ii) showing the connection of the headquarter to the branches. **(3 marks)**
- b) State **two** factors determining the size and shapes of a cells in a cellular network **(2 marks)**
- c) Distinguish between Frequency Division Duplex (FDD) and Time Division duplex (TDD) as used in networks. **(2 marks)**
- d) A transmitter transmits a power of 100W and is used with antenna having a gain of 5dBi. Determine the
- i. EIRP **(2 marks)**
 - ii. Power density at a distance of 10km. **(2 marks)**
- e) State the **three** possible topologies of the ZigBee network **(3 marks)**
- f) Table 1 shows the specifications of two antennas A and B

Table 1

Antenna	Gain	Radiation resistance
A	5.3 dBi	20 Ω
B	4.5dBd	25 Ω

With reasons, state which antenna:

- i. has a higher gain;
 - ii. radiates more power. (2 marks)
- g) Explain why the uplink duplex frequency is higher than the downlink duplex frequency in satellite transmission (1 mark)
- h) Explain the frequency reuse concept as used in cellular networks (2 marks)

QUESTION 2 (15 MARKS)

- a) Describe the content of each of the following registers in a GSM network
- i. Home location register (HLR) (2 marks)
 - ii. Visitor location Home location register (VLR) (2 marks)
- b) Explain how the use of Temporary Mobile Subscriber Identity (TMSI) enhances the security in between the BTS and the MS (2 marks)
- c) A TDMA cellular system consists of a deployment of uniform radii hexagonal cells with a 9-cell re-use pattern. The cell diameter (corner to corner) is equal to 8Km. The system has a total bandwidth of 12.5 MHz (for both up-link and down-link). The channels have a channel spacing of 30 Khz. Determine the following:
- i. Number of traffic channels
 - ii. Number of cells required to cover a total area of $3600km^2$.
 - iii. Co-channel re-use distance D
- (7 marks)
- (Area of a hexagon $A = \frac{3\sqrt{3}R^2}{2}$ where R is the radius of the hexagon)
- d) Distinguish between fixed and dynamic frequency assignments in cellular networks (2 marks)

QUESTION 3 (15 MARKS)

- a) With the aid of diagrams, describe each of the following electromagnetic wave propagation modes
- i. Ground wave (2 marks)
 - ii. Space wave (2 marks)
 - iii. Sky wave (2 marks)
- b) Table 2 shows part of the electromagnetic wave spectrum

Table 2

Frequency band	Frequency	Wavelength
UHF (ultra high frequency)	300 to 3000 MHz	100 to 10 cm
SHF (super high frequency)	3 to 30 GHz	10 to 1 cm
EHF (extremely high frequency)	30 to 300 GHz	10 to 1 mm

Based on Table 2, state the frequency band used for:

- i. 5th generation cellular network
 - ii. Satellite communication in the C band
 - iii. GSM cellular communication (3 marks)
- c) For a Base Station, let $P_T = 10 W$ $f_c = 900Mhz$ $G_T = 2$ and $G_R = 1$. The Mobile Station is at a distance of 5 km,

- i. Determine the received power in dBW. **(4 marks)**
- ii. Given that the sensitivity of the MS is -100dBW, explain whether the received power is adequate **(2 marks)**

QUESTION 4 (15 MARKS)

- a) Describe each of the following methods of implementing **demand –assigned FDMA** in satellite systems
 - i. Polling
 - ii. Centrally controlled random access **(4 marks)**
- b) A satellite at a distance of 40,000 km from a point on the earth’s surface radiates a power of 10 W from an antenna with a gain of 17 dB in the direction of the observer. The satellite operates at a frequency of 11 GHz. The receiving antenna has a gain of 52.3 dB. Determine the received power in dBW. **(5 marks)**
- c) Define each the following terms as used in Wi-Max network reference model
 - i. Access Service Network (ASN)
 - ii. Network Access provider (NAP)
 - iii. Network Service Provider (NSP) **(3 marks)**
- d) Sketch a labelled layout of a WIMAX network architecture, showing the layout of the network components. **(3 marks)**

QUESTION 5 (15 marks)

- a) Distinguish between:
 - i. Coordinator and router devices as applied to Zigbee
 - ii. Piconet and scatternet networks as applied to Bluetooth **[4 marks]**
- b) (i) Table 3 shows short range networks, energy efficiency and range of coverage. Copy and complete the table using these comparison adjectives: **High, medium, low**

Table 3: Short range networks

Network	Energy efficiency	Range of coverage	Throughput
Wi-Fi			
Bluetooth			
Zigbee			

- (ii) Based on the technologies in (i), state the disadvantage of use Wi-Fi technology to support the body area network (BAN). **[5 marks]**
- c) A typical 1.5V watch battery has a capacity of 28mAh. A ZigBee node is to last 2 years on this battery if it operates continuously. If the node turns off its receiver, it reduces the power consumption by 75% during the sleep mode. Determine :
 - i. the power (in watts) the node can consume in 2 years if it operates continuously; **(2 marks)**
 - ii. the power (in watts) the node consumes in 2 years if it uses sleep mode to keep the transceiver on, only 10% of the time; **(2 marks)**
 - iii. how much **longer** the battery life will last in the case of (c) (ii). **(2 marks)**