



UGANDA INSTITUTE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY WEEKDAY PROGRAMME END OF SEMESTER ONE EXAMINATIONS

ACADEMIC YEAR 2024/2025

DEPARTMENT: ICT

SEMESTER: TWO

PROGRAMME(S): DIPLOMA IN ELECTRICAL AND COMMUNICATIONS ENGINEERING

YEAR OF STUDY: TWO

COURSE: MOBILE COMMUNICATIONS TECHNOLOGIES

COURSE CODE : ECE223

DATE: SUNDAY 22TH, JUNE 2025

TIME: 02:00 PM – 5:00 AM

DURATION: 3 HOURS

INSTRUCTIONS:

- (i) This paper consists of two (02) sections, section A and section B.**
- (ii) Attempt all questions in section A both part A and Part B. Also attempt at least three (03) questions from section B.**
- (iii) Credit will be given for use of relevant examples and illustrations.**
- (iv) Begin each number on a new page of the answer sheet.**
- (v) DO NOT write on this question paper.**

SECTION A

Part A (20 Marks)

1. The early FM push-to-talk telephone systems were used in
 - a) Simplex mode
 - b) Half duplex mode
 - c) Full duplex mode
 - d) None of the above
2. The process of transferring a mobile station from one base station to another is
 - a) MSC
 - b) Roamer
 - c) Hand off
 - d) Forward channel
3. The interference between the neighboring base stations is avoided by
 - a) Using transmitters with different power level
 - b) Using different antennas
 - c) All of the above
 - d) Assigning different group of channels
4. Paging systems were based on
 - a) Simplex systems Mobile
 - b) Half duplex systems
 - c) Full duplex systems
 - d) None of the above
5. Radio capacity may be increased in cellular concept by
 - a) Increase in radio spectrum
 - b) Increasing the number of base stations & reusing the channels
 - c) Both a & b
 - d) Increase the antenna transmissions power
6. When a fraction of assigned channel is reserved for handoffs, it is
 - a) Guard channel concept
 - b) Fixed channel assignment
 - c) Dynamic channel assignment
 - d) None of the above
7. Interference in frequency bands may lead to
 - a) Cross talk
 - b) Missed calls
 - c) Blocked calls
 - d) Dropped calls
 - e) All of the above
8. Traffic intensity is expressed in
 - a) Erlangs/sec
 - b) Erlangs
 - c) Bits/s
 - d) dB
9. Hexagon shape is used for radio coverage for a cell because
 - a) It uses the maximum area for coverage
 - b) Fewer number of cells are required

- c) It approximates circular radiation pattern
- d) All of the above

10. Centre excited hexagonal cells use.

- a) Sectorized directional antennas
- b) Omni directional antennas
- c) Yagi uda antennas
- d) None of the above

11. In a fixed channel assignment strategy, if all the assigned channels are occupied, the call

- a) Gets transferred to another cell
- b) Is kept on waiting
- c) Is allocated a different channel from the neighboring cell
- d) Gets blocked

12. The frequency in the GSM is selected by the operator. Further it is divided into

- a) Frame
- b) Packet
- c) Timeslots
- d) Bits

13. Dwell time is the time for

- a) A call within the cell
- b) Completing a Hand off
- c) Waiting for channel allocation
- d) Establishing a call

14. Trunking in a cellular network refers to

- a) Termination of a call
- b) Spectrum unavailability
- c) Accommodating large number of users in limited spectrum
- d) Allocation of communication channels based on priority

15. Umbrella cell approach

- a) Uses large and small cells
- b) Uses different antenna heights
- c) Is used for high speed users with large coverage area and low speed users with small coverage area
- d) All the above

16. Increase in Co- channel reuse ratio indicates

- a) Better transmission quality
- b) Larger capacity
- c) Low co-channel interference
- d) Both a and b
- e) Both a and c

17. Grade of service refers to

- a) Accommodating large number of users in limited spectrum
- b) Ability of a user to access trunked system during busy hour
- c) Two calls in progress in nearby mobile stations
- d) High speed users with large coverage area

18. Friis free space equation:

- 1. Is an expression for noise power.
- 2. Is a function of transmitting and receiving antenna gain.
- 3. Depends upon the distance between transmitting and receiving antenna.

- a) 1 and 2 are correct
- b) 1 and 3 are correct
- c) 2 and 3 are correct
- d) All are correct

19. EIRP is

- 1. Effective Isotropic Radiated Power
- 2. Maximum radiated power available by the transmitter
- 3. A factor of power and gain of transmitter

- a) 1 and 2 are correct
- b) 1 and 3 are correct
- c) All the three are correct
- d) 2 and 3 are correct

20. The free space model of propagation refers to

- 1. Unobstructed line of sight between the transmitter and receiver
- 2. Satellite communication systems and Microwave line of sight radio links
- 3. Propagation along the ground surface

- a) 1 and 2 are correct
- b) 1 and 3 are correct
- c) 2 and 3 are correct
- d) All the three are correct

Part B (20 Marks)

- i. Explain the term **Frequency spectrum** and show any 02 (two) importance of efficient frequency spectrum management to the end user **(3 marks)**
- ii. Outline two key specifications that can be used to differentiate a **2G** communication network from a **3G** communication network. **(2 marks)**
- iii. Define the term **Mobile assisted hand-off** **(2 marks)**
- iv. Outline any two (02) hand off strategies implemented in GSM network. **(2 marks)**
- v. Outline any three types of logical channels that are defined in the **Um** interface. **(2 marks)**
- vi. Outline any two (02) security mechanisms used in 3G networks **(2 marks)**
- vii. Explain the term **Fading** and outline any two causes of fading in wireless networks **(2 marks)**
- viii. Outline the roles of the BSC in a GSM network **(2 marks)**

- ix. A transmitting antenna has a gain of **120** and transmits **-90dBm** of power. Calculate the **EIRP** of the antenna if it operates at 3Mhz. **(3 marks)**

SECTION B

Question 1 (20 Marks)

- (a) Before the introduction of cellular systems, earlier communication systems used broadcasting, outline two (02) disadvantages of broadcasting over cellular networks. **(4 marks)**
- (b) Briefly explain the evolution of the GSM, highlighting the standard name and at least two (02) key specifications for each standard mentioned. **(08 marks).**
- (c) Determine the number of duplex audio communication channels available in a **GSM 1800** system. GSM 1800 has bandwidth of **75MHz** and has a duplex spacing of **95MHz**. Each use radio channel should occupy a band width of **200KHz** and **5MHz** of the allocated spectrum is dedicated to control channels and guard bands. **(4 marks)**
- (d) If the system in (c) above uses **FDMA/TDMA**, and a 7 cells per a cluster, calculate the total number users that can be accommodated by the network cell. **(2 marks)**
- (e) Deduce the downlink frequency of a Mobile station that uses a frequency of **1805MHZ** **(2 marks)**

Question 2 (20 Marks)

- a) Differentiate between a **VLR** and an **HLR** and give any three (03) functions of the HLR in the GSM architecture **(04 marks)**
- b) Outline any 03 kinds of data stored in the HLR in the SIM record **(03 marks)**
- c) Explain two roles played by the following entities in a GSM network, **Media gateway, EIR** and **AUC** **(06 marks)**
- d) Name the different interfaces that used to connect the following entities in a GSM Network
- BTS and MS
 - BTS and BSC
 - MSC and BSC. **(03 marks)**
- e) Outline four functions associated with the **NSS**. **(4 marks)**

Question 3 (20 Marks)

- a. Discuss 03 (three) different strategies that can be implemented to increase capacity of a cellular communication network **(06 marks)**
- b. Calculate the corresponding values of **I** and **j** to design a cellular network of cluster size
- N= 15 (3 marks)**
 - N= 19 (3 marks)**
 - Comment on the results in a(i) and a(ii) above. **(1 marks)**
- c. If a signal-to-interference ratio of 22dB is required for satisfactory forward channel performance of a cellular system, what is the frequency reuse factor **Q** and cluster size **N** that should be used for maximum capacity if the path loss exponent is $n = 4$. Assume that all co-channel cells in the first tier, and all of them are at the same distance from the mobile station. **(10 marks)**

Question 4 (20 Marks)

The transmitter of a BTS broadcasts **60W** towards a BSC using a microwave link. The BTS station uses a parabolic antenna of diameter **600cm** and efficiency of **0.75**. The diameter of the BSC receiving antenna is on **0.9m** with efficiency of **80%**. The BTS and the BSC are located 35km apart. If the BTS and BSC operate in the GSM 900 band at a frequency of **960MHz**, Calculate:

- EIRP of the transmitting antenna in **dBw** **(04 marks)**
- The power of the signal received at the BSC in **(dBm)?** **(06 marks)**
- Calculate the thermal noise in a transmission channel given, ambient temperature **30°C**, bandwidth **90MHz** and Boltzman constant = $1.38 \times 10^{-23} \text{ JoulesS}^{-2}\text{K}^{-1}$ **(04 marks)**
- The figure of Merit of the receiving antenna from (c) above **(03 marks)**
- Deduce the **signal –to-Noise** from (b) and (c) above **(03 marks)**