## INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

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**Question One (30 marks))**

(a) (i) Explain the operation of VSAT communication as an element of satellite communication system. (2 marks)

(ii) A satellite link operating at 28GHz has receiver feeder losses of 1.5 dB and a free-space loss of 178 dB. The atmospheric absorption loss is 1.5 dB, and the antenna pointing loss is 1.5 dB. Calculate the total link loss for clear-sky conditions assuming no other losses.

(b) (i) With the aid of sketches differentiate between a mobile in a cordless communication system and another in a mobile communication system. (4 marks)

(ii) Explain what is meant by isotropic power radiation in mobile communication systems. (2 marks)

(c) (i) Explain what is meant by handoff in a cellular communication system. (3 marks)

(ii) Explain the function of the base transceiver station (BTS) in a cellular communication network. (2marks)

(d) Explain how:

(i) Frequency reuse increases subscriber base in cellular communication networks. (3 marks)

(ii) A 50MHz cellular telephone system uses two 25.5 kHz simplex channels to provide full duplex voice and control channels. Compute the number of channels available per cell if a system uses a four-cell reuse factor. (2 marks)

(e) (i) Explain how each of the factors below is applied to increase signal-to-noise ratio at a receiver in a mobile communication system:

- Space diversity (3 marks)

- Time diversity (3 marks)

(ii) Why is transmit diversity preferred to receive diversity in cellular communication systems? (3 marks)

**Question Two (20 marks)**

(a) (i) Explain how a duplex antenna operates at a mobile radio base station. (4 marks)

(ii) Sketch a basic cellular communication system consisting of four hexagonal cells and its interface to the public switched telephone network and explain how inter-channel interference is caused. (6 marks)

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(i) Describe a design method used to minimize inter-channel interference in cellular telephony. (3 marks)

(b) A mobile communication service provider is allocated a bandwidth of 256 MHz for a regional cellular telephone system. The system uses 50 kHz simplex channels to provide full duplex voice and control channels.

(i) Compute the bandwidth of available duplex channels in the network. (3 marks)

(ii) If the system has a seven-cell reuse factor determine the number of duplex channels available per cell. (4 marks)

**Question Three (20 marks)**

(a) A satellite orbital eccentricity is described by Kepler's law as

$$e = \frac{\sqrt{p^2 - q^2}}{p}$$

where $p$ and $q$ are semimajor and semiminor axes, respectively.

Sketch a well labelled orbit of the satellite when

(i) $p = q$ (5 marks)

(ii) $p > q$ (5 marks)

(b) (i) Sketch a diagram of the satellite parabolic antenna and define the focus (F), the focal length $(f)$ and the aperture $(A_a)$. (6 marks)

(ii) Sketch the radiation pattern of the transmitting antenna in (i) above and calculate the half-power beamwidth (HPBW) for a satellite operating at 2.4 GHz when the antenna diameter is 1.988 metres. (4 marks)

**Question Four (20 marks)**

(a) (i) Differentiate between demultiplexing and multiple access as applies to mobile communication systems. (4 marks)

(i) Explain with the aid of a sketch how time division multiple access (TDMA) enables $n$ subscribers to simultaneously access the mobile communication network. (6 marks)

(b) A three-channel time division multiplexing system for a satellite radio link uses analogue-to-digital (A/D) converters, data demultiplexers and a frequency modulation (FM) modulator in the uplink for the ground station.

(ii) Sketch the schematic diagram of the signal processing system in the ground station.

(6 marks)

(iii)If the output of each A/D converter is 15 kb/s, compute the bandwidth on the uplink channel. (4 marks)

**Question Five (20 marks)**

(a) (i) Sketch a multipath propagation model in a wireless channel prone to reflecting obstacles. (4 marks)

(ii) Explain the occurrence of constructive and destructive interferences at the receiving antenna in a communication system. (4 marks)

(b) In a communication system the received power is related to the transmitted power by the Friis equation

$$P_r = \frac{G_t G_r \lambda^2}{(4\pi)^2 d^2} P_t$$

(i) Explain the meaning of $\lambda$ and $d$ as applies in the equation. (4 marks)

(ii) State the expression for propagation power loss in dB if the antenna gains are unity. (4 marks)

(c) Explain how transmit diversity reduces signal loss due to multipath fading in communication systems. (4 marks)