(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2023/2024 ACADEMIC YEAR

FIFTH YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND COMMUNICATIONS ENGINEERING

COURSE CODE: ECE 516E

COURSE TITLE: ANTENNA & RADIO WAVE PROPAGATION

DATE: THURSDAY 07/12/2023 **TIME:** 3.00 PM - 5.00 PM

INSTRUCTIONS TO CANDIDATES

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

MMUST observes ZERO tolerance to examination cheating

QUESTION ONE (30 MARKS)

1(a) (i) Differentiate between dB, dBW, dBm, dBi and dBd.

(ii). A base station transmits a power of 1 W with a gain of 12 dBd in the direction of a mobile receiver, which has a gain of 0 dBd. The mobile receiver has a sensitivity of -104 dBm. Determine **(I)** the effective isotropic radiated power **(II)** the maximum acceptable path loss.

(4 marks)

(b)(i) A TV optimum viewing distance is stated as four times the picture height. Find the maximum number of lines which can be resolved by the human eye.

(ii) Suppose you are required to design a CCTV system to provide surveillance of an office block,

(I) describe THREE types of cameras that can be used and explain the advantages of using each type of camera,

(II) describe THREE needs assessment activities that you, as an engineer, will have to conduct during the design process.

(6 marks)

(c) Calculate the length of the following antennas and state their radiation resistance at 300 MHz. State any assumptions you make.

(i) dipole;

(ii) folded dipole (twin lead; Z = 300 ohms, velocity factor = 0.8);

(iii) bow tie

(iv) Ground plane

(6 marks)

(d) An aircraft transmits a distress signal at 700 MHz using a 5-Watt transmitter with a 4 dBi gain transmit antenna.

(i) What is the effective isotropic radiated power (in dBW) of the aircraft transmitter?

(ii) If a ground-based receiver detects the distress signal with a 6 dBi antenna at a power level of -86 dBm, estimate the distance between the receiver and the plane in kilometers.

(iii) Suppose that upon closer inspection, the engineers at the ground station realize that they have connected a 200Ω-impedance antenna to a 50Ω coaxial cable to feed the receiver. Calculate this unexpected mismatch factor and its effect on the distance calculation.

(8 marks)

(e) Explain the meaning and significance of the following when used in HF communication.

(i) Lowest Usable Frequency

(ii) Maximum Usable Frequency

(iii) Critical Frequency

(6 marks)

QUESTION TWO (20 MARKS)

(a) Describe the following terms as used in antenna engineering:

(i) Balun

(ii) Beam steering

(iii) Beam width

(6 marks)

(b) (i) Explain the effects of faraday rotation as a function of angle of elevation and frequency.

(ii) A satellite at a distance of 40,000 km from a point on the earth's surface radiates a power of 2 W from an antenna with a gain of 17 dB in the direction of the observer. Find the radiated power density at the receiving point, and the power received by an antenna with an effective area of 10 m^2.

(6 marks)

(c) (i) Justify the choice of rectangular frame with width to height ratio = 4/3 for television transmission and reception.

(ii) Justify the choice of 625 lines for TV transmission. Why is the total number of lines kept odd in all television systems? What is the significance of choosing the number of lines as 625 and not 623 or 627?

(iii) What do you understand by Kell-factor? How does it affect the vertical resolution of a television picture? Show that the vertical resolution increases with increase in number of scanning lines.

(8 marks)

QUESTION THREE (20 MARKS)

(a) (i) Of two dipoles, one using wire conductors and one using thin tubing conductors, which has a wider bandwidth? Explain your answer.

(ii) If a marconi antenna is too short, what can be done to bring it into resonance?

(iii) If a ground plane antenna is too long for the desired frequency of operation, what can be done to make it resonant?

(6 marks)

(b) Suppose you have two identical 200-Ω antennas with 3 dBi peak gain, pointed toward one another and separated by 100m of free-space. To one antenna – the transmitter – you connect a 300 MHz, 1-Volt source with 50-Ω impedance to the antenna. To the other antenna – the receiver – you connect a 50-Ω resistive load. Answer the following questions based on the above scenario.

(i) What is the magnitude of the voltage across the 50-Ω load resistor at the receiver?

(ii) How much total power is the voltage source providing to this system in dBm?

(ii) What is the total loss of the system in dB, comparing the power delivered to the load resistor to the power provided by the source in (ii)?

(8 marks)

(c)(i) State situations which require underground and undersea radiocommunication.

(ii) State, giving reasons, the methods and frequencies used for underground and underwater radiocommunication.

(6 marks)

QUESTION FOUR (20 MARKS)

(a) (i) Discuss the Hata –Okumara Model

(ii) Discuss two methods for mitigating multipath effects in digital transmission networks.

(8 marks)

(b) A parabolic reflector antenna with a diameter of 4.8m operates at 6.2 GHz. Calculate:

(i) the gain;

(ii) the beamwidth

(4 marks)

(c)(i) With the aid of a drawing, describe the principle of operation of a log periodic antenna.

(ii) Suppose you are to design a smart phone antenna solution that operates at 700 MHz (newly allocated cellular band), 900 MHz (original cellular band), 2100 MHz (UMTS band), and 2.45 GHz (WiFi). Using your knowledge of the Chu-Harrington limit, would it be more space efficient to use two antennas on the handset (one for 700-900 MHz and one for 1710-2450 MHz) or a single antenna capable of receiving all 4 bands (700-2450 MHz)? Discuss.

(8 marks)