MACHAKOS UNIVERSITY

University Examinations for 2024/2025 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FIFTH YEAR FIRST SEMESTER EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE548: ANTENNA & PROPAGATION

DATE: 16TH JANUARY 2025 **TIME: 11.00AM - 1.00 PM**

INSTRUCTIONS:
*Answer question **ONE (Compulsory)** and **any other TWO** questions*

QUESTION ONE *(COMPULSORY)* (30 MARKS)

a) Define the following antenna parameters:
   i. Directivity
   ii. Pattern bandwidth. (4 marks)

b) Distinguish between broadside array and end fire antenna array configurations. (6 marks)

c) List any THREE disadvantages of cassegrain feed for parabolic reflector antennas. (3 marks)

d) State FOUR factors that contribute to interference fading. (4 marks)

e) Determine the frequency of wave propagation through an ionosphere layer with refractive index of 0.6 and electron density 3.25×10^5 electrons/cc. Also, determine the corresponding change in frequency, if the refractive index increases by 35%. (7 marks)

f) Briefly discuss with aid of a suitable sketch mechanism of ionospheric propagation. (6 marks)

QUESTION TWO (20 MARKS)

a) There exist a number of factors which affect the propagation of radio waves in an actual environment. Briefly discuss how the following affect radio waves:
   i. The atmosphere
   ii. Interaction with the objects on the ground (4 marks)

b) With the aid of suitable diagrams illustrate how the following diversity techniques are used to mitigate the effects of fading:
   i. Space diversity
   ii. Frequency diversity. (9 marks)

c) A free-space LOS microwave link operating at 10 GHz consists of a transmit and a receive antenna each having a gain of 25 dB. The distance between the two antennas is 30 km and the power radiated by the transmit antenna is 10 W. Calculate:
   i. The path loss of the link and,
   ii. The received power. (7 marks)

QUESTION THREE (20 MARKS)

a) State FIVE desired requirements of reflector feed systems for high aperture efficiency. (5 marks)

b) With the aid a diagram explain the working principle of a centre-fed with spherical reflector. (6 marks)

c) A circular loop antenna has a single turn of 4-mm diameter copper wire. The loop circumference of 0.8 m is 0.08λ at the operating frequency of 30 MHz $\lambda = 10\ m$, which qualifies the antenna as electrically small. Assume $\sigma = 5.8 \times 10^7 S/m$. Determine:
   i. The input impedance
   ii. The radiation efficiency (9 marks)

QUESTION FOUR (20 MARKS)

a) Define the following fading classifications:
   i. Rapid fluctuations
   ii. Short-term fluctuations
   iii. Long-term fluctuations (3 marks)

b) Briefly explain the following terms:
   i. Polarization Fading
   ii. Selective Fading (4 marks)

c) A communication system is to be established at a frequency of 60 MHz with a transmitter power of 1 kW watts. The field strength of the directive antenna is 3 times that of a half-wave antenna. $h_t = 50m,\ h_r = 5m$. Field strength of $80\mu V/m$ is required to give satisfactory reception. Determine the range of the system. (5 marks)

d) Illustrate the following phenomena using suitable sketches:
   i. Duct propagation
   ii. Troposcatter. (8 marks)

QUESTION FIVE (20 MARKS)

a) Define horn antenna as a waveguide. (3 marks)

b) List out the advantages of terminating the waveguide into electromagnetic horn. (4 marks)

c) State pattern multiplication theorem. (3 marks)

d) Calculate the directions of the maxima and the nulls of the array factor of an array of two infinitesimal dipoles oriented along the z-direction, kept at $z_1 = -0.125\lambda$ and $z_2 = 0.125\lambda$, and carrying currents $I_1 = e^{-j\pi/4}$ and $I_2 = e^{j\pi/4}$, respectively. (10 marks)