MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ……

UNIVERSITY ORDINARY EXAMINATION

2023/2024 ACADEMIC YEAR

……. YEAR **SECOND** SEMESTER EXAMINATION FOR BACHELOR …….

EET 633 – ANTENNA SYSTEMS & DESIGN

DURATION: 3 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question one and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a. A hypothetical Isotropic antenna is radiating in free space. At a distance of 100m from the antenna, the total electric field (E_q) is measured to be be 5v/m. Find the
   i. Power density (wrad) (5marks)
   ii. Power radiated (Prad) (5marks)

b. A … dipole with a total loss resistance of 1ohm is connected to a generator whole internal impedance is 50 + j25 ohms. Assuming that the peak voltage of the generator is 2V and the impedance of the dipole, excluding the loss resistance, is 73 + j42-5 ohms, find the power.
   i. Supplied by the source (real) (5marks)
   ii. Radiated by the antenna (5marks)
   iii. Dissipated by the antenna. (5marks)

SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

a. For an antenna with a maximum linear dimension of D, find the inner and outer boundaries of the Frequel region so that the maximum phase error does not exceed. (5marks)

b. A resonant center-fed dipole is connected to a 50-ohm line. It is desired to maintain the input VSWR = 2.
   i. Determine the largest input resistance of the dipole to maintain the VSWR = 2.
   ii. Evaluate the length (in wavelengths) of the dipole to meet the specification.
   iii. Calculate the radiation resistance of the dipole. (13marks)

c. A base station cellular communication system utilizes arrays of …. Dipoles as transmitting and receiving antennas. Assuming that each element is lossless and that the input power to each of the … dipoles is 1 watt , determine at 1,900mHz and a distance of 5km the maximum:
   i. Radiation intensity
   ii. Radiation density (in walts/m^2) for each … dipole. This determines the safe level for human exposure to EM radiation. (7marks

QUESTION THREE (20 MARKS)

a. A circular loop, of loop radius … and … is used as transmitting/receiving antenna in a back-pack radio communication system at 10 MHz. The wire of the loop is made of copper with a conductivity of 5.7 x 10^7 S/m. Assuming the antenna is radiating in free space determine the:
   i. Radiation resistance of the loop
   ii. Loss resistance of the loop (assume that its value is the same as if the wire were straight)
   iii. Input resistance
   iv. Input impedance
   v. Radiation Efficiency (15marks)

b. Design a circular loop of constant current such that its field intensity vanishes only at $\emptyset = 0°$ ($\emptyset = 180°$) and 90°. Find its
   i. Radius
   ii. Radiation resistance
   iii. Directivity (10marks)

QUESTION FOUR (25 MARKS)

i. Given the array of Figure 4 (a) and (b), find the nulls of the total field when d = ……. And $\beta = 0$

ii. $\beta = +\frac{\pi}{2}$

iii. $\beta = -\frac{\pi}{2}$ (15marks)

b. Consider an array of two identical infini….. dipoles oriented as shown in Figure 4 (a), (b) for a separation distance d and phase excitation difference B between the elements, find the angles of observation where the nulls of the array occur. The magnitude excitation of the elements is the same. (10marks)

QUESTION FIVE (25 MARKS)

a. Design a linear array with spacing between the elements of …. Such that it has zeros at $\emptyset = 0°, 90° \; and \; 180°$. Determine the number of elements, their excitation, and plot the derived pattern. Use Schelkunoff's method. (15marks)

b. Determine the current distribution and the approximate radiation pattern of a line source placed along the z-axis whose desired radiation pattern is symmetrical about $\emptyset = {}^{\pi}/_{2}$, and it is given by
   Insert formular…… (10marks)