MACHAKOS UNIVERSITY

University Examinations for 2023/2024 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (TELECOMMUNICATION AND INFORMATION TECHNOLOGY)

SPH 408: ANTENNAS

DATE: **TIME:**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Define each of the following with respect to antennas

i. Directivity
ii. Gain
iii. Half power beamwidth

(3 marks)

b) Distinguish between near field and far field as applied to antenna radiation

(2 marks)

c) Determine the maximum power density at a distance of 10 m from a Hertzian dipole which is radiating 1W.

(3 marks)

d) A dipole antenna 12 cm long is operating at 300 MHz Determine the radiation resistance of the antenna.

(3 marks)

e) Determine the power density in W/m^2 at a distance of 25km from an antenna that is radiating 5KW with a directivity of 36 dB.

(3 marks)

f) Determine the uplink and downlink gain of a 2.7 m diameter parabolic dish antenna at Ku-band (14/12 GHz), if it is to be used in a satellite ground station. Take the antenna efficiency to be 65%.

(7 marks)

g) Explain why a helical antenna is often used for satellite links.

(2 marks)

h) A base station transmits a power of 10W into a feeder cable with a loss of 10 dB. The transmit antenna has a gain of 12 dBd in the direction of a mobile receiver, with antenna gain 0 dBd and feeder loss 2 dB. The mobile receiver has a sensitivity of -104 dBm.

i. Determine the effective isotropic radiated power.
ii. Determine the maximum acceptable path loss.

QUESTION TWO (20 MARKS)

a) Describe the construction of rectangular horn antennas.

(5 marks)

b) A pyramidal antenna has dimensions 40 cm and 48 cm respectively in the E and H $-$plane is used to radiate 5 Watts of power at 3000 MHz Determine :

i. aperture area;
ii. antenna gain.

(6 marks)

c) The antenna in (b) is used to transmit a signal 4.8 km away. An identical antenna is used as a receiver. At the receiving point, determine the:

i. power density ;
ii. Maximum electric field strength;
iii. Power received.

(8 marks)

QUESTION THREE (20 MARKS)

a) Explain the difference in **axial** and **normal mode** of operation of helical antennas

(4 marks)

b) Figure 1 shows a helical antenna. State how each of the following features affect the directivity of the antenna.

i. Spacing between turns, S.
ii. Number of turns, N
iii. Diameter of the helix, D

(3 marks)

c) A helix antenna operates at $3\ GHz$ and has the dimension spacing between turns $S = 3\ cm$, the diameter of the helix $D = 8cm$ and number of turns $N = 15$. Determine each of the following.

i. The half-power point beamwidth
ii. The first nulls beamwidth
iii. Directivity

(9 marks)

d) Table 1 gives design specifications of a helix antenna. Determine the number of turns, N required to meet the specifications. (4 marks)

Table 1

Quantity	Values
Frequency of operation	4 GHz
Spacing between turns	4 cm
Directivity of antenna	8 cm
Directivity	30 dB

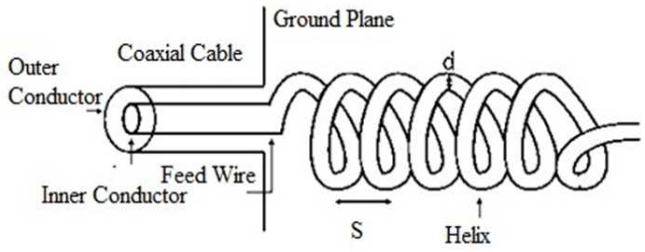

Figure 1

QUESTION FOUR (20 MARKS)

a) With aid of diagrams, distinguish between **end fire array** and **broadside array**

(4 marks)

b) An end array consisting of several half wavelength isotropic radiators has a directive gain of 30

Determine the:

i. Array length

ii. Width of the major lobe

(6 marks)

c) (i)With the aid of diagrams, describe any **two feed** systems for parabolic reflector antenna systems

(ii)A parabolic reflector antenna has a diameter $D = 20\ m$ and is designed to operate at $f = 6\ GHz$ with an illumination efficiency of $\eta = 0.54$. Determine the antenna gain in decibels.

(10 marks)

QUESTION FIVE (20 MARKS)

a) Describe each of the following electromagnetic wave propagation modes

i. Ground wave propagation

ii. Space wave propagation

iii. Sky wave propagation

(6 marks)

b) Two stations $500\ Km$ apart are communicating through the ionosphere with ionic concentration of 10^{12} electrons/m^3 at an effective height of 240kM. Determine the:

i. Approximate angle of incidence;
ii. Critical frequency;
iii. Maximum usable frequency.

(10 marks)

c) Describe the tropospheric wave propagation

(4 marks)