# MACHAKOS UNIVERSITY

**University Examinations for 2020/2021**

**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: 12/8/2021** **TIME:8:30 – 10:30 AM**

**INSTRUCTIONS:**

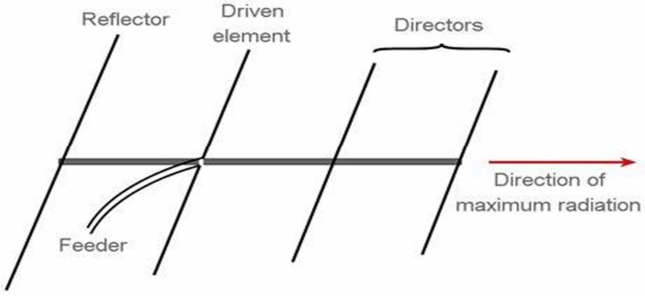
This paper consists of **FIVE** questions. Answer Question **ONE** and any other **TWO** questions

Take: Copper characteristics:

$$\mu_c = 4\pi \times 10^{-7}\ H/m$$
$$\sigma_c = 5.8 \times 10^{7}\ S/m$$

**Question One (COMPULSORY-30 marks)**

(a) Figure 1 shows a Yagi-Udda antenna.




Explain:

i. effect of Increasing the number of directors;
ii. effect of Increasing the number of reflectors;
iii. the common areas of application of the antenna.

(4 marks)

(b) Define each of the following as applied to antennas

i. Directivity
ii. Gain
iii. Half power beamwidth

(3 marks)

(c) A vertical wire of length 1m carries a current of 1 ampere at 10 Mhz. Determine the:

i. Radiated field strength at a distance of 500 Km
ii. The total maximum radiated power
iii. The radiation resistance

( 8 marks)

(d) A thin dipole is $\frac{\lambda}{15}$ long. If it has a loss resistance of 1.5$\Omega$ .Determine the:

i. Directivity, D
ii. Gain, G
iii. Effective aperture $A_e$
iv. Beam solid angle $\Omega$

(8 marks)

(e) (i)Distinguish between broadside and end fire array

(ii)A broad side array operating at 300MHz consists of four half wave dipole spaced $\frac{\lambda}{2}$. Each element carries a current in the same phase and of 0.5 A amplitude: Determine the

i. Radiated power
ii. FNBW of the array

( For half wave dipole, $R_r = 73\Omega$)

(7 marks)

**QUESTION TWO ( 20 MARKS)**

(a) Distinguish between far field and near field antenna radiations (2 marks)

(b) The far field, electric and magnetic field vectors for a Herzian dipole are given by:

$$\tilde{E}_\theta = \frac{jI_0 k\eta_0}{4\pi}\left(\frac{e^{-jkr}}{r}\right) sin\theta \ \ V/m$$

$$\tilde{H}_\phi = \frac{\tilde{E}_\theta}{\eta_0}$$

Show that the maximum power density at a distance $r$ is given by

$$P_r = \frac{15\pi I_0^2}{r^2}\left(\frac{l}{\lambda}\right)^2$$

(8 marks)

(c) A 2-m-long centre-fed dipole antenna operates in the AM broadcast band at 1Mhz. The dipole is made of copper wire with radius of 1mm.

i. Determine the antenna
   I. Radiation efficiency
   II. Gain
ii. It is required for the antenna to radiate 80W. Determine the required:
   I. Antenna CURRENT
   II. Power the generator needs to supply to the antenna (10 marks)

**QUESTION THREE (20 MARKS)**

(a) Explain the importance of antenna arrays

(3 marks)

(b) Show that for a two element array A and B, separated by a distance d, the magnitude of the total radiated field at the observation point P , $E_{TR}$ , is given by

$$E_{TR} = 2E_0 Cos\left(\frac{\beta d Cos\phi}{2} + \frac{\delta}{2}\right)$$

where $\delta$ is the phase angle between the excitations, $d$ is the distance separating the elements.

(7 marks)

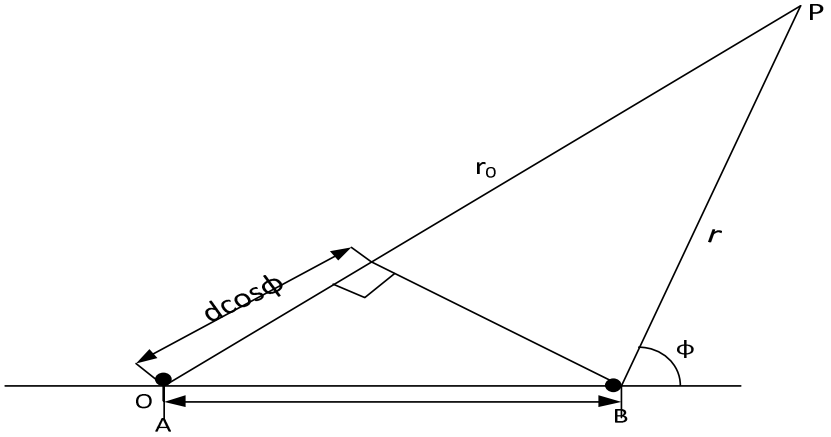



Figure 2

(c) A uniform linear array consists of 12 isotropic in-phase isotropic sources spaced $\frac{\lambda}{2}$ apart.

Determine the:

i. HPBW
ii. Level of first side lobe
iii. Beam solid angle directivity
iv. Effective aperture

(10 marks)

**QUESTION FOUR ( 20 MARKS)**

(a) State **two**

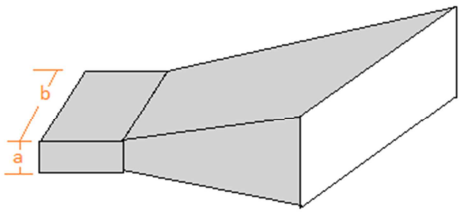
i. types of horn antennas
ii. areas of application of horn antennas (4 marks)

(b) A pyramidal horn antenna of aperture dimensions $a = 40cm, b = 48\ cm$in the $E$ and $H$ plane respectively is used to radiate 5 watts of power at 3000 MHz

Determine the

i. The gain of the antenna
ii. Power density at a distance of 4.8 Km
iii. Maximum field intensity at a distance of 4.8 Km

iv. Amount of power that would be picked if an identical antenna is used at the receiver.




Pyramidal Horn Antenna

(13 marks)

(c) A parabolic antenna is operating at $8\ Ghz$ and has first nulls beamwidth of $6^0$ Determine the:

i. Half power point beamwidth

ii. Power gain

(3 marks)

**QUESTION FIVE ( 20 MARKS)**

(a) (i) Derive the Friss Power transmission equation

(ii) Using the equation in (a)(i) show that the free space path loss is given by

$$L_p(dB) = 20log_{10}\,f(MHz) + 20\,log_{10}D(Km) + 34.5$$

(10 marks)

(b) A communication link is to be set up between two stations $A$ and $B$ using $\frac{\lambda}{2}$ antennas for maximum directive gain of 1.64. The transmitted power is $1\ KW$, the distance between transmitter and receiver is 10km. Determine the

i. Effective aperture of the receiver

ii. Maximum power received by the receiver

(10 marks)