KIBABII UNIVERSITY
(KIBU)

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER SUPPLIMENTARY EXAMINATIONS

FOR THE DEGREE
OF
BACHELOR OF EDUCATION SCIENCE

COURSE CODE: SPH 426

COURSE TITLE: ELECTROMAGNETIC THEORY

DATE: 15/11/2022 **TIME:** 11:00AM-1:00PM

INSTRUCTIONS TO CANDIDATES

TIME: 2 Hours

Answer question ONE and any TWO of the remaining.

Symbols used bear the usual meaning.

KIBU observes ZERO tolerance to examination cheating

Question One (30 marks)

a) Describe the basic properties of charge (3 marks)

b) Differentiate between electrostatics and magnetostatics (2 marks)

c) If there are several point charge $q_1, q_2, \ldots\ldots\ldots q_n$ at a distance $r_1, r_2, \ldots\ldots\ldots r_n$ from Q, show the value of the total force acting on Q and the Electric field around it (4 marks)

d) Show that for a point charge q at the origin, the flux of E through a sphere of radius r is $\frac{q}{\varepsilon_0}$ (3 marks)

e) Find the field outside a uniformly charged solid sphere of radius R and total charge q (4 marks)

f) An infinite plane carries a uniform surface charge σ. Find its electric field (4 marks)

g) Find the capacitance of two concentric spherical metal shells with radii a and b (3 marks)

h) Find the magnetic field a distance z above the centre of a circular loop of radius R which carries a steady current I (3 marks)

i) State the four Maxwell's equations with a correction term (4 marks)

Question Two (20 marks)

a) Suppose the xy plane forms the boundary between two linear media. A plane wave of frequency ω travelling in the z-direction and polarized in the x-direction, approaches the interface from the left, it gives rise to a reflected wave which travels back to the left in medium (1) and a transmitted wave which continues in the right in medium (2), determine the reflection coefficient and the transmission coefficient of this wave (10 marks)

b) Determine the transverse magnetic waves equations for electromagnetic wave confined in a hollow wave guide, assuming the wave guide is a perfect conductor (10 marks)

Question Three (20 marks)

a) Find the electric field a distance z above the midpoint of a straight line segment of Length 2L which carries a uniform line charge λ (6 marks)

b) A long cylinder carries a charge density that is proportional to the distance from the axis $\rho = ks$, for some constant k. Find the electric field inside this cylinder (8 marks)

c) Find the potential of a uniformly charged spherical shell of radius R (6 marks)

Question Four (20 marks)

a) Show how much work would be done to assemble a collection of point charges q_i (8 marks)

b) Find the electric field produced by a uniformly polarized sphere of radius R (6 mark)

c) A metal sphere of radius a carries a charge Q. It is surrounded out to radius b, by a linear dielectric material of permittivity ε. Find the potential at the Centre (relative to infinity) (6 marks)

Question Five (20 marks)

a) A spherical shell of radius R, carrying a uniform surface charge σ, is set spinning at angular velocity ω. Find the vector potential it produces at a point r (10 marks)

b) By using Maxwell's equations in regions of space where there is no charge or current and decoupling the equations by applying a Curl. Determine the wave equations for E and B (10 marks)