DEDAN KIMATHI UNIVERSITY OF

TECHNOLOGY UNIVERSITY EXAMINATION

2017/2018

THIRD YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF

BACHELOR OF SCIENCE IN

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING AND BACHELOR OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 2305 - ELECTROMAGNETICS I

DATE: August 2017 **Duration: 2 Hour**

Instructions

This examination paper contains five questions. **Attempt question one and any other two** questions. **Question one is compulsory** and carries 30 marks. All the other questions carry 20 marks each. Neatness, clarity, and precise explanations must be observed.

Question One

a) Define electric field strength as it relates to electromagnetics **(2 Marks)**

b) State the Gauss law, its equation and explain all the symbols **(4 Marks)**

c) Describe what happens as an airplane, charged negatively by friction with a charge −Q, is landing and finally touches down. **(6 Marks)**

d) Point charges 5nC and -2nC are located at (2, 0, 4) and (-3, 0, 5), respectively.

   i. Determine the force on a 1-nC point charge located at (1,-3, 7). **(4 Marks)**

   ii. Find the electric field E at (1,-3, 7). **(4 Marks)**

e) A circular loop located on $x^2 + y^2 = 9,\ z = 0$ carries a direct current of 10A along a_ϕ.

   i. Determine H at (0, 0, 4) and (0, 0, -4). **(6 Marks)**

   ii. Sketch the flux lines due to the circular current loop **(4 Marks)**

Question Two

a) What is the difference between an inhomogeneous linear dielectric, and a homogeneous nonlinear dielectric? **(4 Marks)**

b) A finite sheet $0 \le x \le 1,\ 0 \le y \le 1$ on the z = 0 plane has a charge density $\rho_s = xy(x^2 + y^2 + 25)^{3/2}\, nC/m^2$. Find

i. The total charge on the sheet **(4 Marks)**

ii. The electric field at (0, 0, 5) **(3 Marks)**

iii. The force experienced by a -1mC charge located at (0, 0, 5) **(3 Marks)**

c) Three circular loops are made of three equal pieces of wire of length b, one with a single turn, one with two turns, and one with three turns of wire. If the same current, ***I*** exists in the loops and they are situated in a uniform magnetic field of flux density B,

i. Determine the maximal moment of magnetic forces on the three loops. **(3 Marks)**

ii. Solve for the moments if I = 5A, b = 50 cm, and B = 1T. **(3 Marks)**

Question Three

a) Define Electric Scalar potential **(3 Marks)**

b) State the Lorentz force equation and explain the meaning of all the symbols used **(3 Marks)**

c) Define the following terms as relates to magnetic materials

i. Diamagnetic material **(3 Marks)**

ii. Paramagnetic material **(3 Marks)**

d) The xy-plane serves as the interface between two different media. Medium 1 ($z < 0$) is filled with a material whose $\mu_r = 6$, and medium 2 ($z > 0$) is filled with a material whose $\mu_r = 4$. If the interface carries current $(1/\mu_0)\ \mathbf{a_y}$ mA/m, and $B_2 = 5\mathbf{a_x} + 8\mathbf{a_z}$ mWb/m^2 find H_1 and B_1. **(8 Marks)**

Question Four

a) Describe the process of making a xerographic copy **(6 Marks)**

b) The electric field intensity in polystyrene (er = 2.55) filling the space between the plates of a parallel-plate capacitor is 10 kV/m. The distance between the plates is 1.5 mm. Calculate:

i. D **(3 Marks)**

ii. P **(3 Marks)**

iii. The surface charge density of free charge on the plates **(3 Marks)**

iv. The surface density of polarization charge **(2 Marks)**

v. The potential difference between the plates **(3 Marks)**

Question Five

a) Using appropriate illustrations, state the electrostatic boundary conditions between

iii. Two dielectrics **(4 Marks)**

iv. a conductor and a dielectric **(2 Marks)**

b) Two point charges -4μC and 5μC are located at (2,-1,3) and (0,4,-2) , respectively.

i. Find the potential at (1,0,1) assuming zero potential at infinity. **(4 Marks)**

ii. If point charge 3μC is located at the origin in addition to the two charges of part (i) above, find the potential at (-1,5,2) assuming $V(\infty)= 0$. **(4 Marks)**

c) A hemispherical surface of radius **R** is situated in a uniform magnetic field of flux density **B**. The axis of the surface makes an angle **α** with the vector **B**. Determine the magnetic flux through the surface. **(6 Marks)**