UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

MAIN EXAMINATION MAY 2018

TITLE OF PAPER: **ELECTROMAGNETIC FIELDS I**

COURSE CODE: **EE341/EEE342**

TIME ALLOWED: **THREE** HOURS

INSTRUCTIONS:

1. Answer all four (**4**) questions
2. Each question carries 25 marks.
3. Marks for different sections are shown in the right-hand margin.

This paper has 3 pages including this page.

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QUESTION 1

A) The electric field of a traveling electromagnetic wave is given by $E(z,t) = 15\sin(3\pi \times 10^7 t + \frac{\pi z}{15} + \frac{\pi}{5})$ (V/m). Determine the following:

(i) The direction of the wave, [1 mark]

(ii) The frequency *f*, [3 marks]

(iii) The wavelength, and [3 marks]

(iv) The phase velocity. [3 marks]

B) A cube 2 m on a side is located in the first octant in a Cartesian coordinates system, with one of its corners at the origin. Find the total charge contained in the cube if charge density is given by $\rho_v = 0.03xyz^2 (\text{mC/m}^3)$. [8 marks]

C) Evaluate the curl of the vector field $\boldsymbol{A} = \hat{\boldsymbol{x}}(x^2y) + \hat{\boldsymbol{y}}(3yz) + \hat{\boldsymbol{z}}z$ at a point (1, -1, 2). [7 marks]

QUESTION 2

A) Given a vector magnetic potential $\boldsymbol{A} = -\hat{\boldsymbol{z}}\frac{\mu_0 I_0}{4}(3x^2 + y^2)$ (Wb/m) apply ***vector Poisson's equation*** $\nabla^2 A = -\mu J$ to obtain the current density. [10 marks]

B) A voltage V applied across the terminals of a wire establishes an electric field $E = \hat{\boldsymbol{x}}20(\text{mVm})$. If the length of the wire is 20m, the diameter is 2 mm, and its conductivity is 5.8×10^7 S/m. Determine the following:

(i) The voltage applied to the wire, (3 marks)

(ii) The current flowing in the wire, (3 marks)

(iii) The current density on the wire, (3 marks)

(iv) The resistance of the wire, and (3 marks)

(v) The power dissipated in the wire. (3 marks)

QUESTION 3

Four point charges are located in free space at points with Cartesian coordinates as follows:

$q_1 = 10\ \mu C$ at (-4, -3, 0), $q_2 = 1\ \mu C$ at at (3, 4, 0), $q_3 = 1\ \mu C$ at (0, 2, 0), and

$q_4 = 10\ \mu C$ at (0, 0, 2). All distances are in meters. Find the electric field E at (0, 0, 0).

[25 marks]

QUESTION 4

A) Determine the divergence of the vector field $E = \hat{x}4x^2z + \hat{y}2yz + \hat{z}x^2z$ and evaluate it at (4, 2, 3). [10 marks]

B) Apply Coulomb's law to find the electric force acting on $q_2 = 20\ \mu C$ charge located at point (4, 3, 5) due to $q_1 = 20\ \mu C$ charge located at point (1, 1, 1) when both charges are in free space with Cartesian coordinates, and all distances in meters. [9 marks]

C) What are the three branches and associated conditions of electromagnetics? [6 marks]