UNIVERSITY OF ESWATINI

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

MAIN EXAMINATION MAY 2019

TITLE OF PAPER: **ELECTROMAGNETIC FIELDS I**

COURSE CODE: **EE341/EEE342**

TIME ALLOWED: **THREE** HOURS

INSTRUCTIONS:

1. Answer all five (**5**) questions
2. Each question carries 20 marks.
3. Marks for different sections are shown in the right-hand margin.

This paper has 3 pages including this page.

DO NOT OPEN THE PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR.

QUESTION 1

A) A certain electromagnetic wave travelling in seawater was observed to have an amplitude of 100 (V/m) at a depth of 10 m, and an amplitude of 80 (V/m) at a depth of 100m. What is the attenuation constant of seawater? (3 marks)

B) A laser beam of light propagating through the atmosphere is characterized by an electric field given by $E(x,t) = 100\,cos(3\pi \times 10^{15}\,t - 10^{7}x)$ (V/m), where x is the distance in from the source in meters. Determine the direction of the wave travel and phase velocity. (4 marks)

C) A lossless 50 transmission line is terminated in a load with $Z_L = (50 + j25)\ \Omega$. Calculate the following:

(i) The reflection coefficient Γ, (3 marks)

(ii) The standing-wave ratio, (2 marks)

D) For a 75 Ω lossless transmission line which is 0.2λ–long and having voltage reflection coefficient equal to $0.4e^{j45^0}$ at its load, calculate its input admittance. (8 marks)

QUESTION 2

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

B) 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). [5 marks]

C) 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]

QUESTION 3

A) An antenna with a load impedance $Z_L = (75 + j\,45)\ \Omega$ is connected to a transmitter through a 50 Ω– lossless transmission line. If under matched conditions the transmitter can deliver 20 W to the load, how much power can it deliver to the load under unmatched conditions? (9 marks)

B) A voltage source given by

$$v_s(t) = 10cos(2\pi \times 10^4 t - 45) \quad (V)$$

is connected to a series RC load. If R = 10KΩ and C =0. 5627 nF, obtain the **phasor** current $\tilde{I}_s$. (8 marks)

C) Find the Laplacian of the function $V = 4x^2y^2z^3$ (3 marks)

QUESTION 4

A) Explain how to determine of the direction of wave propagation of a traveling wave when the wave is expressed in the time domain, and in the phasor domain. (10 marks)

B) Why is vector algebra and calculus necessary for studying electromagnetic primary quantities? (6 marks)

C) What is the physical meaning of the divergence of an electric field vector? (4 marks)

QUESTION 5

A) What are electromagnetic constitutive parameters of a material? (3 marks)

B) What classifies a material as homogeneous, a perfect dielectric, isotropic, and a perfect conductor? (4 marks)

C) What is the difference between magnetization curves of hard and soft ferromagnetic materials? (4 marks)

D) "Electromagnetic force consists of an electrical component and a magnetic component. The electrical force is similar to gravitational force".

(i)Give the fundamental differences between electric and magnetic fields. (8 marks)

(ii) State why electrical and gravitational fields are said to be similar. (1 mark)