UNIVERSITY OF ESWATINI

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

MAIN EXAMINATION DECEMBER 2018

TITLE OF PAPER:	**ELECTROMAGNETIC FIELDS II**
COURSE CODE:	**EEE441 / EE441**
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.

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QUESTION 1

a) According to Faraday's law, under what three conditions can an emf be generated in a closed conducting loop. (3 marks)

b) An electromagnetic wave propagating through a 1 m^2 across section area of seawater has an electric field with time variation given by $E = \hat{z}10\cos(2\pi \times 10^9 t)$. If the permittivity of water is $81\varepsilon_0$ and its conductivity is 4 (S/m), determine conduction current and displacement current. (8 marks)

c) An inductor formed by 100 turns of a thin wire conducting wire into a circular loop of radius 0.01 m. The inductor is in the x-y plane with its center at the origin, and connected to a resistor of 90Ω. In the presence of a magnetic field $\mathbf{B} = 0.5(\hat{y} + \hat{z}5)\sin(10^3 t)$, find

i. the magnetic flux density linking a single turn of the inductor, (5 marks)
ii. the transformer emf, and (5 marks)
iii. the induced current in the circuit (assume the wire resistance is 10 Ω). (4 marks)

QUESTION 2

a) What is the difference between the input impedance and the characteristic impedance of a transmission line. (4 marks)

b) A lossless transmission line with characteristic impedance equal to 75 Ω, length equal to 0.5λ, is connected to a load $Z_L = (150 + j75)$ Ω. The amplitude of the incident voltage is 10 volts. Calculate the following:

i. The coefficient reflection at the load. (4 marks)
ii. The input impedance of the line. (7 marks)
iii. The net power flowing towards (and then absorbed by) the load. (4 marks)

c) A TM wave propagating in a dielectric-filled waveguide of dimensions a = 4b = 8 cm, and of unknown permittivity has a magnetic field with y-component given by

$$H_y = 10\cos(25\pi x)\sin(100\pi y)\times\sin(3\pi\times10^{10}t - 150\pi z) \text{ (mA/m)}.$$

Determine the mode numbers and the phase velocity. (6 marks)

[Hint: $\widehat{H}_y = \frac{J\omega\varepsilon}{K_c^2}\left(\frac{m\pi}{a}\right)E_0\cos\left(\frac{m\pi x}{a}\right)\sin\left(\frac{n\pi y}{b}\right)e^{-j\beta z}$]

QUESTION 3

An right-hand circular polarized plane-wave with electric field magnitude of 10 (mV/m) is traveling in the z-direction in a dielectric medium with $\varepsilon = 9\varepsilon_0$ and $\mu = \mu_0$, and $\sigma = 0$. If the frequency is 0.1 GHz, obtain the expression for E(z, t) and H(z, t). (25 marks)

QUESTION 4

a) What is the difference between Brewster angle and acceptance angle. (6 marks)

b) Which point on the Smith chart represents a matched load? (1 marks)

c) A 50 Ω lossless transmission line is to be matched to a load with $Z_L = 60 - j60$ using a short circuited stub. Use the smith chart to determine the length and distance between the load and stub. (18 marks)