UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

MAIN EXAMINATION MAY 2017

TITLE OF PAPER:	**ELECTROMAGNETIC FIELDS II**
COURSE CODE:	**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.

This paper has 3 pages including this page.

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QUESTION 1

A 2.4 GHz generator with series impedance $Z_g = 10\ \Omega$ and voltage source given by

$$v_g(t) = 10\sin(\omega t + 45^0) \qquad (V)$$

is connected to a load $Z_L = (100 + j100)\ \Omega$ through a 50-Ω, 41.35-cm long lossless transmission line as shown in Figure Q1. The phase velocity u_p of the line is 0.8c where $c = 3 \times 10^8$ which is the velocity of light in a vacuum. Find

a) The phase constant β, (4 marks)
b) The reflection coefficient Γ, (4 marks)
c) The input impedance Z_{in}, (6 marks)
d) The incident voltage amplitude $V_0^+ = \left(\frac{\hat{V}_g V_{in}}{Z_g + Z_{in}}\right)\left(\frac{1}{e^{j\beta l} + e^{-j\beta l}}\right)$, and (6 marks)
e) The phase voltage $\tilde{V}(d)$. (5 marks)

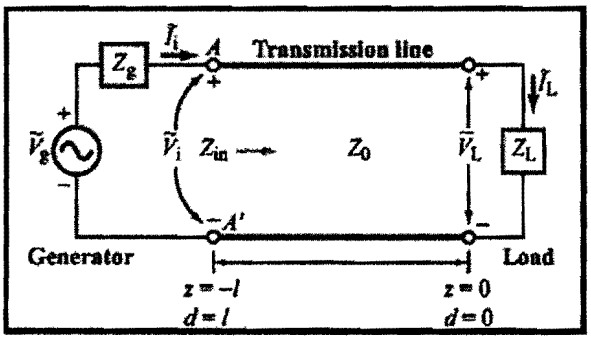

Figure Q1

QUESTION 2

a) Define the quality factor of a cavity resonance. (2 marks)
b) What happens at the Brewster angle for a given polarization? (3 marks)
c) When is a wave said to be linearly polarized, and briefly explain how a wave can be linearly polarized? (5 marks)
d) The electric field of an electromagnetic wave propagating in air is given by
$\boldsymbol{E}(z,t) = \hat{x}4\cos(\omega t - 2z) + \hat{y}3\sin(\omega t - 2z)$ (v/m).
Find $\hat{H}(z)$. (15 marks)

QUESTION 3

A load impedance $Z_L = 20 - j40\ \Omega$ is connected to a 50-Ω, 100 MHz transmission line. Insert a shunt element to eliminate reflections towards the sending of the line. Use a Smith chart to locate the possible insert location (d_1 and d_2) in wavelengths, and length l_1 and l_2 of shorted stubs. *Note: Two possible solutions exist that's why d_1 and d_2.* (25 marks)

QUESTION 4

An inductor is formed by winding N = 100 turns of a thin conducting wire into circular loop of radius a =10 cm. The inductor loop is in the x-y plane with its center at the origin, and connected to a resistor R, as shown in Figure Q4.

I) In the presence of a magnetic field $\boldsymbol{B} = (\hat{y}0.5 + \hat{z}4)cos10^3t$ find

a) The magnetic flux linking a single turn of inductor, (8 marks)

b) The transformer emf, (7 marks)

c) The polarity of $\boldsymbol{V}_{emf}^{tr}$ at t =0, (2 marks)

d) The induced current in the circuit for R=500 Ω, and (4 marks)
Hint: *The wire resistance is very small compared to R.*

II) Find $\boldsymbol{V}_{emf}^{tr}$ if $\boldsymbol{B} = 0.5(\hat{y} + \hat{x}1.5)sin10^3t$ (4 marks)

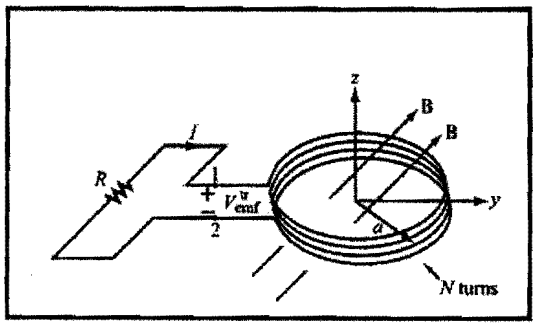

Figure Q4