UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

MAIN EXAMINATION DECEMBER 2014

TITLE OF PAPER:	**ELECTROMAGNETIC FIELDS II**
COURSE CODE:	**EE441**
TIME ALLOWED:	**THREE** HOURS

INSTRUCTIONS:

1. Answer **all** five 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.

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Question 1

a) With reference to ***Faraday's law*** state three conditions in which ***emf*** can be generated in a closed conducting loop. (3 marks)

b) An inductor is formed by winding 10 turns of a thin conducting wire into a circular loop of radius 20 cm. The inductor loop is connected to a 2.2 KΩ resistor marked R as shown in Figure 1. If the magnetic field $\boldsymbol{B} = (\hat{x} + \hat{z})100\sin(10^3 t)$, find the following

i. the magnetic flux density, (8 marks)

ii. the transformer emf, (3 marks)

iii. the polarity of the transformer emf at t = 3.142 msec, and (3 marks)

iv. the current in the circuit. (3 marks)

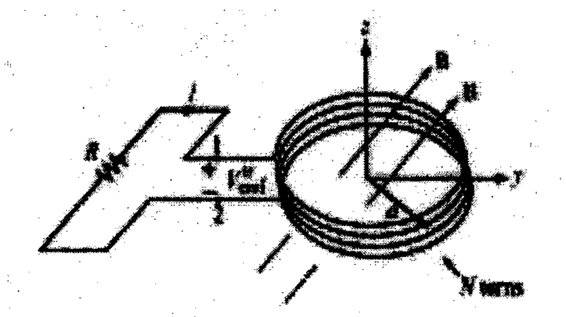

Figure 1

Question 2

A load impedance $Z_L = 40 + j70\ \Omega$ is connected to a 50 Ω transmission line. Insert a shorted stub to eliminate reflections towards the sending end of the line. Specify the locations of insertion points and corresponding lengths of shorted stubs (in wavelengths). (20 marks)

Question 3

A 50 Ω lossless transmission line connected to a 75 Ω resistive load is excited by a 5 Volts amplitude rectangular pulse of duration $\tau = 1$ ns that starts at t =0. If the length of the transmission line is 0.9 m, the generator resistance is 12.5 Ω , and the phase velocity is c:

a) determine the reflection coefficients at the load and the sending end, (4 marks)

b) determine the initial voltage on the line for the first step and second step, and (4 marks)

c) draw the voltage bounce diagram. (12 marks)

Question 4

An RHC polarized plane wave with electric field magnitude of 4 (mV/m) is traveling in the +y-direction in a dielectric medium with $\varepsilon_r = 6$, $\mu = \mu_0$, and $\sigma = 0$. If the frequency is 100MHz, determine

a) the wavenumber k, (3 marks)

b) the intrinsic impedance η, (3 marks)

c) the expression for $\widehat{\boldsymbol{E}}(y)$, (5 marks)

d) the expression for $\widehat{\boldsymbol{H}}(y)$, and (5 marks)

e) the expression for H(y,t). (4 marks)

Question 5

a)

i) State Snell's law of refraction. (2 marks)

ii) In the visible part of the electromagnetic spectrum, the index of refraction of water is 1.21. What is the critical angle for the light waves generated by an upward looking underwater light source? (3 marks)

b) A beam of light is normally incident in air upon a glass surface. If the surface is the plane z=0 and the relative permittivity of glass is 2.25. determine

i. the reflection coefficient, and (8 marks)

ii. the fraction of the incident power transmitted into the glass medium. (7 marks)