UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

MAIN EXAMINATION DECEMBER 2012

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

INSTRUCTIONS:

1. Answer any **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

Use a Smith chart to determine the input impedance Z_{in} of the feed line for the lossless transmission line shown below in Figure 1. All lines have the characteristic impedance of $Z_0 = 50\ \Omega$. (25 marks)

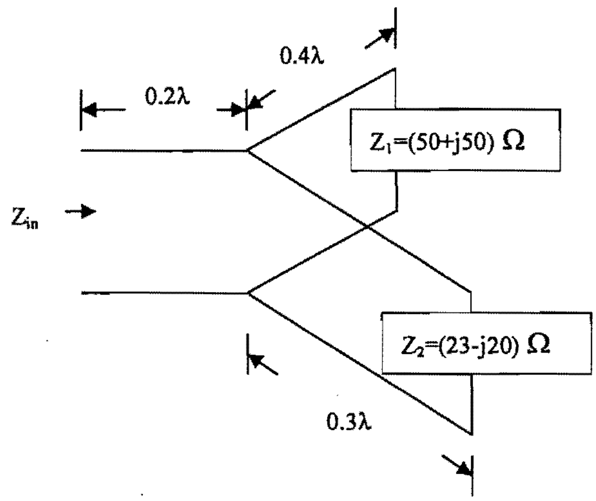

Figure 1

Question 2

A 90 millimeter section of a 50 Ω transmission line is driven by a source with

$v_g(t) = 12\cos(6\pi \times 10^9 t - 36.937^0)$ (V) and $Z_g = 50\ \Omega$, is terminated in a load $Z_L = (75 - j100)\ \Omega$.

Determine:

a) λ on the line, (2 marks)

b) the reflection coefficient at the load, (4 marks)

c) the voltage standing wave ratio, (2 marks)

d) the input impedance, and (8 marks)

e) the input voltage $v_i(t)$. (9 marks)

Question 3

A beam of light with wavelength 0.6 μm is normally incident in air upon a glass surface. If the surface is situated in the plane z = 0 and the relative permittivity of glass is 2.25, determine:

a) the intrinsic impedances η_1 and η_2, (6 marks)

b) the reflection coefficient Γ, (3 marks)

c) the location of the electric field maxima in medium 1 (air), and (4 marks)

d) the fraction of the incident power transmitted into the glass medium. (12 marks)

Question 4

In a medium with $\varepsilon = 36\varepsilon_0$ and $\mu=\mu_0$ the electric field intensity of an electromagnetic wave is

$\widetilde{\mathbf{E}} = (\hat{x} + j\hat{y})30e^{-jkz}$ (V/m).

Determine the associated time–harmonic magnetic field intensity **H**(z,t) and find the value of *k*. (25 marks)

Question 5

A TM wave propagating in a dielectric-filled waveguide of unknown permittivity has a magnetic field with y-component given by

$H_y = 10\cos(50\pi x)\sin(100\pi y) \times \sin(15\pi \times 10^{10} t - 100\pi z)$ (mA/m).

If the guide dimensions are a = 2b = 2 cm, determine:

a) the mode numbers, (4 marks)

b) the relative permittivity of the material in the guide, (7 marks)

c) the phase velocity, (2 marks)

d) obtain an expression for E_x. (12 marks)

Figure A.6 A standard Smith chart

Impedance or Admittance Coordinates