MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2021/2022 ACADEMIC YEAR

THIRD YEAR **SECOND** SEMESTER EXAMINATION FOR, BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EES310– ELECTROMAGNETIC WAVES

DURATION: 2 HOURS

Instructions to candidates:

1. Answer question One and Any Other Two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

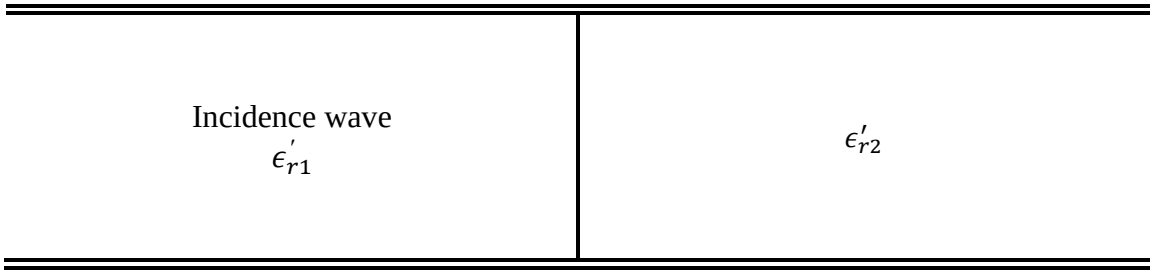
a) Express Maxwell's Equation both in point and integral forms. (6marks)

b) Starting from Maxwell's equation derive the expression of Poynting theorem. (8marks)

c) Differentiate between the following as used in guided wave (4marks)
   i. Transverse Electric (TE) waves and transverse (TM) waves
   ii. Phase velocity and group velocity.

d) A 100 Hz uniform plane wave propagating in the forward z direction in a lossless medium for which $\epsilon_r = 5$, $\mu_r = 1$. Determine:
   i. Phase velocity
   ii. Phase constant
   iii. Wavelength
   iv. Electric field intensity
   v. Magnetic field intensity.

e) A parallel – plate guide is partially field with two lossless dielectrics Fig Q1(e) where $\epsilon_{r1} = 4$, $\epsilon_{r2} = 2.1$ and $d = 1cm$.
   At a certain frequency, it is found that the TM_1, mode propagates through the guide without suffering any reflective loss at the dielectric interface. (5 marks)
   i. Determine this frequency
   ii. Determine if the guide is operating at a single TM mode at one frequency found in part e(i)



SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

a) Define the following terms (4marks)
   i. Uniform plane waves
   ii. Wave polarization

b) Determine the polarization of a plane wave with

$$\boldsymbol{H_S}(z) = H_0 e^{-j\beta z}\boldsymbol{a_x} - 2H_0 e^{-j\beta z}\boldsymbol{a_y}$$

7marks)

c) A uniform plane Wave propagating in a medium has

$$\boldsymbol{E} = 2e^{-\alpha z}\sin(10^8 t - \beta z)\boldsymbol{a_y}$$

If the medium is characterised by $\epsilon_r = 1, \mu_r = 20$, and $\sigma = 3\ s/m$, determine α, β and $\boldsymbol{H}$. (9marks)

QUESTION THREE (20 MARKS)

a) Each conductor of a two wire transmission line has a radius of $0.5mm$, their centre to centre separation is $0.8cm$. Let $f = 150\ MHz$ and assume σ and θ_c are zero. Determine the dielectric constant of the insulting medium if: (8marks)
   i. Characteristic impedance $Z_0 = 300\Omega$
   ii. Line capacitance $C = 20pF/m$
   iii. Phase velocity $v_p = 2.6 \times 10^8 m/s$

b) Determine R, L, C and G for a coaxial cable with $a = 0.25mm$, $b = 2.50mm$ and $c = 3.30mm$, E$\epsilon_r = 2, \mu_r = 1, \theta_c = 1 \times 10^7 S/m$ $\sigma = 1 \times 10^{-5} S/m$ and $f = 300\ MHz$ (12marks)

QUESTION FOUR (20 MARKS)

a) A beam of yellow light with wavelength $0.6\ \mu m$ is normally incident in air upon a glass surface. Assume the glass is sufficient thick as to ignore its back surface if the surface is situated in the plane $z = 0$ and the relative permittivity of glass is 2.25, determine the fraction of the incident power transmitted into the glass medium. (5marks)

b) A perpendicularly polarized wave in air is obliquely incident upon a planar glass air interface at an incidence 30°. The wave frequency is $600\ THz$, which corresponds to green light and the index of refraction of the glass is 1.6. If the electric field amplitude of the incident wave is $50V/m$. Determine the following: (15marks)
   i. The reflection and transmission coefficients
   ii. The instantaneous expression for $\boldsymbol{E}$ and H in the glass medium.