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(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND COMMUNICATIONS ENGINEERING

COURSE CODE: ECE 322

COURSE TITLE: ELECTROMAGNECTICS 11

DATE: WEDNESDAY, APRIL, 27TH, 2022. **TIME:** 8:00 - 10:00 AM

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

QUESTION ONE

(a)(i) Explain the four equations of Maxwell (8 marks)

(ii) Basing on Maxwell's equations, state the tree properties of plane electromagnetic wave (4.5 marks)

(b) Define the following terms as they are applied to electromagnetic waves

(i) Attenuation

(ii) Skin depth

(iii) A lossy dielectric (3 marks)

c) A plane wave in a nonmagnetic medium has $E = 50\sin(10^8t + 2z)a_y$ V/m, find

(i) λ (ii) f (iii) ε_r (5 marks)

d) State the poynting Theorem (2 marks)

(e) The electric field in free space is given by $E = 50\cos(10^9t - \beta_x)a_{y\ V/M}$ (7 marks)

i. Find the direction of wave propagation

ii. Calculate β and the time it takes to travel a distance $\lambda/2$

iii. Sketch the wave at t=0, T/4 and T/2

QUESTION TWO

(a) Explain the meaning of the following terms

(i) Permittivity (1 mark)

(ii) Magnetization (1mark)

b) Given that copper has a conductivity of 5.823×10^7 s/m calculate its skin depth at 10 GHz (2 marks)

c) Using integral forms of equations, show why Maxwell's third law is referred to as Faraday's law of magnetic induction (4 marks)

d) i) From the analysis of Maxwell's equations, explain the three conclusions that can be drawn about the properties of a plane electromagnetic wave (3 marks)

(ii) Show that for every wavelength of distance travelled, a wave undergone a phase of 2π radians (2marks)

e) In a nonmagnetic medium

$$E = 4 \sin (2\pi \times 10^7 t - 0.8x) az \quad V/M$$

Find

i) ε_r (3 marks)

ii) η (2marks)

iii) Time average power carried by the wave (2marks)

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f) Explain the conditions under which a circuit where the current flows in only one direction can be able to emit electromagnetic waves (2marks)

QUESTION THREE

a) Explain the difference between electric fields and magnetic fields (2 marks)

b) For an electromagnetic wave propagation inside a good conductor, show that electric and magnetic fields are out of phase by 45° (3 marks)

c) Explain what's meant by plasma and how it arises in the atmosphere (5 marks)

d) In a lossless medium for which n= 60π, μ_r=1 and

$H = -0.1 \text{ Cos } Wt - Z\,\tilde{a}x + 0.5 \text{ Sin } Wt - Z\tilde{a}y$ A/M

calculate the following

(i) ε_r (2 marks)

(ii) ω (2 marks)

(iii) E (6marks)

QUESTION FOUR

a) Using appropriate equations explain the following

i) Brewster angle

ii) Law of reflection

ii) Law of refraction

(3marks)

b) Show how Gauss law magnetic and amperes circuital law can generate the wave equation for magnetic field (3marks)

c) (i) compute the apparent speed of light in water whose index of refraction is 1.33 (2 marks

ii) With the application of Fresnel's equations derive the Brewster's angle (6 marks)

d) State and explain in integral form Maxwell's four equations (6 marks)

QUESTION FIVE

a) (i) plot E field and H fields as functions of Z at t = 0 (6marks)

(ii) Plot E field and H field at Z= 0 (2 marks)

iii) Explain the term transverse electromagnetic (TEM) wave (2marks)

(b) In free space ($Z \leq 0$), a plane wave with $H = 10 \cos (10^8 t - BZ)\ a_x$ mA/M is incident normally on lossless medium ($\varepsilon = 2\varepsilon_0$, $\mu = 8\ \mu_0$ in region $Z \geq 0$ .Determine: (i) the reflected wave H_r, E_r (ii) transmitted wave H_t, E_t

(10marks)

(c) Explain the differences between homogeneous and inhomogeneous electromagnetive wave equations (3 marks)