



MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 415: ELECTRODYNAMICS AND INSULATING MATERIALS

DATE: 14/12/2017

TIME: 8.30-10.30 AM

INSTRUCTIONS:

Answer QUESTION ONE and any other TWO questions. QUESTION ONE carries 30marks, others carry 20 marks each.

Constants: $q = 1.6 \times 10^{-19} C$, $\epsilon_0 = 8.85 \times 10^{-12} F/m$, $\mu_0 = 4\pi \times 10^{-7} H/m$

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Explain the following material properties:-
 - i) permittivity
 - ii) permeability . (4 marks)
- b) Demonstrate application of integral theorems in electrodynamics. (4 marks)
- c) Discuss the types of insulating materials (4 marks)
- d) Explain the following material, isotropic and anisotropic. (6 marks)
- e) Discuss the Dielectric Permittivity Tensor (4 marks)
- f) Distinguish Biaxial and Uniaxial media (6 marks)

QUESTION TWO (20 MARKS)

- a) Discuss the near and far-fields from the perspective of a radiating dipole antenna. (5 marks)
- b) Explain dielectric and wave polarization. (4 marks)

- c) Discuss Electric field vector **E**, Dielectric displacement field vector **D** and polarization density **P** and explain relations between them. (5 marks)
- d) Derive Helmholtz equation and compare this to wave equation. (6 marks)

QUESTION THREE (20 MARKS)

- a) A transmission media has properties $\epsilon_r=4$, $\mu_r=1$ and negligible conductivity. Calculate the following in this media:-
 - i. Wave impedance (2 marks)
 - ii. Phase velocity (2 marks)
- b) Briefly discuss metals, ceramics and semiconductors showing properties as used in electrical engineering. (6 marks)
- c) Demonstrate how the scalar and vector potentials determine the fields for time-dependent vector fields. (4 marks)
- d) Describe three classifications of dielectrics indicating effect of electric field on each. (6 marks)

QUESTION FOUR (20 MARKS)

- a) Derive an expression for Poynting vector. (4 marks)
- b) Define polarization and discuss the same with respect to axial ratio and tilt angle. (6 marks)
- c) i) For an air-filled rectangular waveguide of 3cm x 2cm, calculate cutoff frequency f_c . (4 marks)
- ii) How does this cut-off frequency affect other parameters of the waveguide? (6 marks)
- d) Discuss with illustration wave velocity, phase velocity and group velocity. (6 marks)

QUESTION FIVE (20 MARKS)

- a) The EM fields of UPW in lossless, isotropic and uniform dielectric are given as $E=500\cos(10^7t - kz)a_x$. $H=1.1\cos(10^7t - kz)a_x$. Phase velocity =0.5c

Calculate the following:-

- (i) Permittivity, ϵ_r ,
- (ii) Permeability μ_r
- (iii) Wavenumber k
- (iv) Wave impedance η (8 marks)
- b) With equation, show force F on a charge Q moving at a velocity v in an electric field E and magnetic flux density B. (3 marks)
- c) Derive Laplace and Poisson equations (3 marks)
- d) Discuss classification of material in terms of permittivity tensor (6 marks)