



# MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE  
IN ELECTRICAL AND ELECTRONICS ENGINEERING

SUPPLEMENTARY EXAMINATION

EEE 415: ELECTRODYNAMICS AND INSULATING MATERIALS

DATE: 28/8/2017

TIME: 2.00-4.00 PM

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## INSTRUCTIONS

*Answer questions One and any other Two Questions.*

*Question One carries 30 marks. The remaining questions carry 20 marks each.*

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

## QUESTION ONE

- a) Show and explain Maxwell's equations in differential form . (6 marks)
- b) Demonstrate integral theorems and illustrate the application in electrodynamics. (4 marks)
- c) Discuss the types of insulating materials (4 marks)
- d) Explain the following materials, isotropic, anisotropic and dielectric materials (6 marks)
- e) Using Maxwell's equations to derive wave equations (6 marks)
- f) Discuss the permeability and permittivity of materials and how in a media they affect wave propagation (4 marks)

## QUESTION TWO

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

- c) Discuss Electric field vector **E**, Dielectric displacement field vector **D** and electric potential vector **P** vectors in electrodynamics and explain relations between them. Assume a linearly polarizable and isotropic medium. (5 marks)
- d) Derive Helmholtz equation and discuss its meaning. (6 marks)

### QUESTION THREE

- 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) Describe the factors influencing electric breakdown of insulating materials. (4 marks)
- d) Describe three classifications of dielectrics indicating effect of electric field on each. (6 marks)

### QUESTION FOUR

- a) Derive an expression for Poynting vector. (4 marks)
- b) Use Maxwell's equations to derive Helmholtz equation and explain the equation. (6 marks)
- c) Explain wave propagation modes in a waveguide (4 marks)
- d) Discuss with illustration wave velocity, phase velocity and group velocity. (6 marks)

### QUESTION FIVE

- a) Using equations of vector and scalar potentials  $A(x,t) = \text{Re}\{A_0 e^{i(k \cdot x - \omega t)}\}$  and  $\Phi(x,t)=0$ , demonstrate the relationship between the magnitudes of electric vector field **E** and magnetic flux density vector **B**, ie the ratio **E/B** (5 marks)
- b) Discuss basic types of waveguides. (4 marks)
- c) Derive Laplace and Poisson's equations (5 marks)
- d) A transmission line is a medium of electromagnetic wave propagation.
  - i. Show the important wave propagation characteristics for a transmission line using distributed line parameters. (2 marks)
  - ii. How are these characteristics for a lossless transmission line (2 marks)
  - iii. How will this be for a distortionless transmission line (2 marks)