THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

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MAIN EXAMINATION

JANUARY – APRIL 2019 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS

REGULAR PROGRAMME

PHY 302: ELECTRICITY AND MAGNETISM

Date: APRIL 2019	**Duration: 2 Hours**
INSTRUCTIONS: Answer Question ONE and any other Two Questions	

Q1. a) Define

i) current density. **(2marks)**

ii) magnetic vector potential. **(2marks)**

iii) magnetic moment. **(2marks)**

b) i) What are equipotential surfaces? **(2marks)**

ii) What is meant by the term displacement current? **(2marks)**

iii) Give the relation between magnetic flux density and magnetic field intensity. **(2marks)**

iv) Write down the magnetic boundary conditions. **(2marks)**

c) The magnetic flux linkage of a coil wire increases steadily by 90 mWb in a time of 450 μs.

i) Show that the rate of change of magnetic flux linkage is 200 Wb s^{-1}**.** **(3marks)**

ii) What is the emf induced across the coil by the rate of change of magnetic flux linkage **(3marks)**

d) The wing span of an Airbus A300 is 44.8 m.

i) What area is swept out per second when the plane is in level flight at 250 m s^{-1}? **(3marks)**

ii) If the vertical component of the Earth's magnetic field is 50 μT, what potential difference is induced between the tips of the Airbus wings?

(3marks)

e) Show that the magnetic field strength inside a toroid coil of which has N turns carrying a current $I$is given by$H(r)\frac{¿}{2\pi r}$ where *r* is the radial distance from the center of the coil **(4marks)**

Q2. a) Give the relationship between potential gradient and electric field. (1mark)

i) What is the physical significance of div D ? **(2marks)**

ii) What are the sources of electric field and magnetic field?

(2marks)

iii) State and proof Stokes theorem. **(8marks)**

b) i) State Biot - Savert law **(1mark)**

ii) using the law stated in b(i), derive an expression for the magnetic field strength at a point on the axis of a circular loop of a wire of radius$a$ carrying a current I as a function of the distance x measured along the axis from the center of the circle. **(6marks)**

Q3. a) Define

i) Dielectric strength. **(2marks)**

ii) Define electric dipole **(3marks)**

b) State Amperes circuital law. **(3marks)**

c) What are the significant physical differences between Poisson ‘s and Laplace’s equations?. **(2marks)**

d) Find an expression for the potential in the region between two infinite parallel planes , the potential on the planes being given by the following :

$$\varphi(z=0)=5\cos 4x\cos 3y$$

$$\varphi(z=1)=6(\cos h5)\cos 4x\cos 3y$$

(10marks)

Q4. a) State the principle of superposition of fields. **(2marks)**

b) Define mutual inductance **(2marks)**

c) Derive

i) Maxwell’s equation from electric Gauss law **(8marks)**

ii) Maxwell's equation from magnetic Gauss law **(8marks)**

Q5. a) Define self-inductance **(2marks)**

b) State Faraday's law of electromagnetic induction **(2marks)**

c) State Lenz law. **(2marks)**

d) The current through an inductor of self inductance L varies with time as $I = I_0 e^{-\gamma t}$ where $I_0 \wedge \gamma$ are constants.

i) Derive an expression for the energy released as a function of time, assuming that the resistance in the circuit is negligible. **6marks)**

ii) Show explicitly for this case, that the total energy released over a very long time is independent of γ **(8marks)**

END