# KIBABII UNIVERSITY

## UNIVERSITY EXAMINATIONS
## 2017/2018 ACADEMIC YEAR

### THIRD YEAR SECOND SEMESTER
### SUPPLEMENTARY/ SPECIAL EXAMINATIONS

**FOR THE DEGREE OF BACHELOR OF SCIENCE IN PHYSICS AND BACHELOR OF EDUCATION (SCIENCE)**

**COURSE CODE:** SPH 314

**COURSE TITLE:** ELECTROMAGNETISM

**DURATION: 2 HOURS**

**DATE: 12/10/2018** **TIME: 3-5PM**

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INSTRUCTIONS

a) Answer question **ONE** and any other **TWO** of the remaining
b) Question **ONE** carries **30MARKS** and the remaining carry **20 MARKS** each.
c) Symbols used bear usual meaning.

## QUESTION ONE (30 MARKS)

a) In terms of direction of magnetic field flux and magnetization differentiate between paramagnets and diamagnets **(2marks)**

b) Differentiate between paramagnetism and diamagnetism in terms of **(4marks)**
   i. Magnetic susceptibility
   ii. Magnetic permeability
   iii. Relative permeability
   iv. Temperature dependence

c) Define the following terms **(2marks)**
   i. Magnetic flux
   ii. Magnetic hysteresis

d) Consider an electron rotating around its orbit with current ***I***, sweeping an area ***ds***. Show that its magnetic moment $m = \frac{1}{2}evr$. **(4marks)**

e) Given $\vec{B} = \mu_0(\vec{H} + \vec{M})$, show that $\chi = \frac{\mu_m}{\mu_0} - 1$ **(3marks)**

f) A toroid wound with 80turns/m of wire carries a current of 10A. The torus is iron which has a magnetic permeability, $\mu_m = 2400\mu_0$ under given condition. Find $H$ and $B$ inside the iron **(4marks)**

g) State Curie-Weiss law **(2marks)**

h) At what point is Curie's law invalid **(2marks)**

i) A loop of wire is placed in a uniform magnetic field. For what orientation of the loop is the magnetic flux a maximum? **(1mark)**

j) State Faraday's law of induction? **(2marks)**

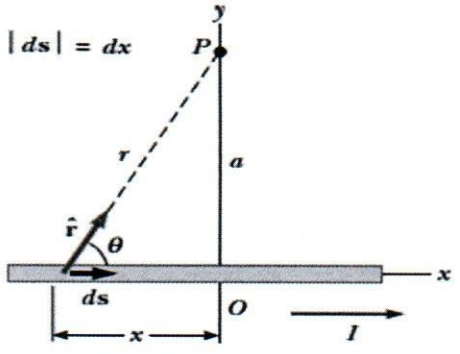
k) State Lenz's law **(2marks)**

l) Define Poynting vector **(2marks)**

## QUESTION TWO (20 MARKS)

a) A toroid wound with 80 turns/m of wire carries a current of 10A. The torus is iron which has a magnetic permeability, $\mu_m = 2400\mu_0$ under given condition. Find $H$ and $B$ inside the iron **(4marks)**

b) Consider a thin, straight wire carrying a constant current $I$ and placed along the $x$ axis as shown in Figure below.
   (i) Determine the magnitude and direction of the magnetic field at point $P$ due to this current in terms of angle θ. **(12 marks)**



(ii) Suppose the wire is infinitely long, determine the magnitude of the magnetic field at point $P$ **(4 marks)**

## QUESTION THREE (20 MARKS)

a) Find the time constant of the circuit shown in Fig. 4 **(3 marks)**

b) The switch in Fig. 4 is closed at $t = 0$. Calculate the current in the circuit at $t = 2.00$ ms **(4 marks)**

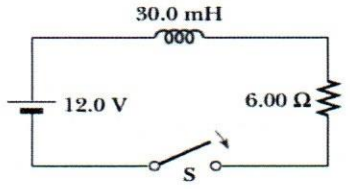



Fig. 4

c) From Curie-Weiss law show that total magnetic dipole moment acting on a volume $v$, is given by $C\frac{B_0}{T}v$ where $C$ is Curie's constant, $B_0$ is the applied external field, $T$ is the Curie temperature. **(4marks)**

d) Given a region whose field is due to a solenoid with total magnetic flux density $\vec{B}$ such that $\vec{B} = \overrightarrow{B_0} + \overrightarrow{B_m}$ where $\overrightarrow{B_0}$ is the field due to current carrying conductor while $\overrightarrow{B_m}$ is the field produced by the magnetic substance, show that $\vec{B} = \mu_0(\vec{H} + \vec{M})$ **(9 marks)**

## QUESTION FOUR (20 MARKS)

a) A metal ring is placed near a solenoid, as shown in Fig. 1 below

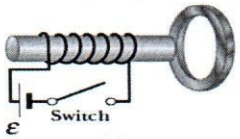



Fig. 1

Find the direction of the induced current in the ring

i. At the instant the switch in the circuit containing the solenoid is thrown closed **(1mark)**

ii. After the switch has been closed for several seconds **(1mark)**

iii. At the instant the switch is thrown open **(1mark)**

b) State four different ways in which an emf can be induced in a given circuit **(4 marks)**

c) Briefly explain any two applications of Faraday's law of induction? **(8 marks)**

d) A coil consists of 200 turns of wire. Each turn is a square of side 18 cm, and a uniform magnetic field directed perpendicular to the plane of the coil is turned on. If the field changes linearly from 0 to 0.50 T in 0.80 s, what is the magnitude of the induced emf in the coil while the field is changing? **(5marks)**

## QUESTION FIVE (20 MARKS)

a) A long solenoid of radius $R$ has $n$ turns of wire per unit length and carries a time-varying current that varies sinusoidally as $I = I_{max}\, cos\, \omega t$, where $I_{max}$ is the maximum current and $\omega$ is the angular frequency of the alternating current source as shown in Fig. 2

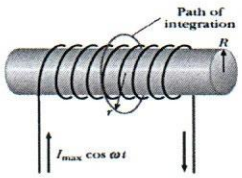



Fig. 2

i. Determine the magnitude of the induced electric field outside the solenoid at a distance $r > R$ from its long central axis. **(7marks)**

ii. What is the magnitude of the induced electric field inside the solenoid, a distance $r$ from its axis? **(4marks)**

b) Consider the circuit shown in the Fig. 3, which contains a battery of negligible internal resistance, resistor ***R*** and an inductor ***L*** connected at terminals "a" and "b".

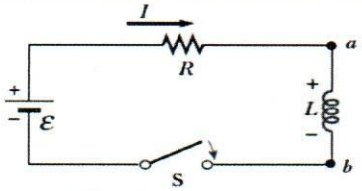



Fig. 3

Apply Kirchhoff's loop rule to this circuit, traversing the circuit in the clockwise direction, and hence show that the current flowing in the circuit ($I$) is given by $I = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau}\right)$, given that $\tau = \frac{L}{R}$ **(9marks)**