CARMEL COLLEGE OF ARTS, SCIENCE & COMMERCE FOR WOMEN, NUVEM-GOA
SEMESTER END EXAMINATION, AUGUST 2020

Semester: VI **Subject:** Physics

Electromagnetic Theory – II and Theory of Relativity (PYC 110)

Total Marks:30 **Date:**07/08/2020 **Duration:**2 hours **Total Number of Pages:**02

Instructions:

1) *All questions are compulsory, however internal choice is available.*
2) *Figures to the right indicate maximum marks to the question.*
3) *Symbols have their usual meanings unless otherwise stated.*
4) *Draw neat diagram wherever necessary.*
5) *Use of non-programmable calculator is permitted.*
   Constants: $\boldsymbol{c = 3 \times 10^8 m/s}$ ***and*** $\boldsymbol{\mu_0 = 4\pi \times 10^{-7} Ns^2/C^2}$.

Q 1. Answer **any five** of the following **(5 x 2 marks = 10)**

a) What do you mean by magnetic scalar potential? Write an expression for it in terms of magnetic dipole moment $\vec{m}$.

b) Give schematic representation of atomic spins for the following materials
(i) Ferromagnetic (ii) Antiferromagnetic

c) The magnetic susceptibility of Silicon is -0.4×10^{-5}. Calculate the flux density and magnetization when magnetic field of $5 \times 10^5\ A/m$ is applied.

d) Draw a neat diagram of Helmholtz coil? Explain it's construction and use.

e) Write the set of Maxwell's equation for time varying fields and give the physical significance of each.

f) State and explain the postulates of special theory of relativity.

g) Discuss expected and observed result of Michelson Morley experiment. How was the result interpreted?

h) Simultaneity is genuinely a relative concept, not absolute one. Affirm this concept with an example.

Q II Answer **any four** of the following **(4 x 5 marks = 20)**

1) A solid conducting wire of cross-sectional radius *R* carries a current density given by $J = J_0(1 - r/R)$, where r is the distance from the axis and J_0 is a constant. Find the magnetic field at *(i) r > R* and *(ii) r < R*.

2) Show that the energy loss due to hysteresis is $W = \oint H\, dB$, where $W \rightarrow$ work done by the field, $H \rightarrow$ magnetization field.

3) Write the boundary conditions satisfied by the magnetic field vectors $\vec{B}$ *and* $\vec{H}$ at the interface of two media and solve the following:
The magnetic field in region 1 and 2 separated by *y=0* are given by $\vec{\boldsymbol{B}}_{\mathbf{1}} = \mathbf{3}\hat{\boldsymbol{x}} + \mathbf{5}\hat{\boldsymbol{y}}$ and $\vec{\boldsymbol{B}}_{\mathbf{2}} = \mathbf{3}\hat{\boldsymbol{x}} + \mathbf{3}\hat{\boldsymbol{y}} + \mathbf{5}\hat{\boldsymbol{z}}$ respectively. Find the ratio of magnetic susceptibility $\left|\frac{\boldsymbol{\mu_1}}{\boldsymbol{\mu_2}}\right|$, where μ_1 and $\mu_2 \rightarrow$ is the relative permeability in region 1 and region 2 respectively.

4) Derive Einstein's relativistic velocity addition equation using Lorentz transformation equations.

5) Derive Einstein's mass energy relation. Explain the role of potential energy in Einstein's mass – energy relation

6) (i) Two electrons leave a radioactive sample in opposite directions with a speed of 0.6 c with respect to the sample. What is the speed of one electron relative to the other according to Newtonian mechanics? What is the relativistic result?

(ii) Find the momentum and mass of a visible photon of wavelength 5000 nm. Plank's constant h=6.63x10^{34} J.s.
