CARMEL COLLEGE OF ARTS, SCIENCE & COMMERCE FOR WOMEN, NUVEM-GOA

SEMESTER END EXAMINATION, JULY 2021

Semester: VI **Subject:** Physics

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

Total Marks:30 **Date:**14/07/2021 **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 I. 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) Draw a neat, labeled diagram of Helmholtz coil (current loops of N turns, radius R and carrying current I). Find the magnetic dipole moment of each current loop.

c) Can magnetic flux be zero? Explain

d) Give any two sources of magnetic field. Define the vector magnetic intensity, also mention it's S.I. units.

e) What does energy loss due to Hysteresis mean? Provide a brief discussion, with the help of a BH curve.

f) Write the set of Maxwell's equation in free space and give the physical significance of each.

g) What was the problem with Galilean Transformation? How did Einstein resolve it?

h) Find the relativistic mass (*in units of* eV/c^2) of an electron whose velocity is 0.99c.

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

a) 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 induction in medium with $\mu_{r1} = 3000\ for\ y = 0$ is given by $\vec{\boldsymbol{B_1}} = (3\hat{\boldsymbol{x}} + \mathbf{5}\hat{\boldsymbol{y}} + 5\hat{\boldsymbol{z}})\ \boldsymbol{T}$. Find the magnetic induction in a medium with $\mu_{r2} = 6000$ for y=0. Note that $\mu_{r1}\ and\ \mu_{r2}$ are the relative permeability in region 1 and region 2 respectively.

b) Give schematic representation of atomic spins for ferromagnetic, antiferromagnetic, paramagnetic and ferrimagnetic materials. Give a mathematical expression for the magnetic intensity inside a ferromagnetic material. Discuss Ferromagnetic domains.

c) State Faraday's law of electromagnetic induction. Derive an expression for the same in differential form.

d) Derive relativistic equations for Doppler effect in light using Lorentz transformation equations.

e) (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?

(ii) A hospital's linear accelerator produces electron beams for cancer treatment. The accelerator is 1.6 m long and the electrons reach a speed of 0.98*c*. How long is the accelerator in the electrons' reference frame?

f) A proton (rest mass = 1.67×10^{-27} kg) has total energy that is 4 times its rest energy. What are (i) the kinetic energy of the proton; (ii) the magnitude of the momentum of the proton?
