U.G. 3rd Semester Examination - 2022

PHYSICS

[HONOURS]

Generic Elective Course (GE)

Course Code : PHY-H-GE-T-01&03

(Electricity and Magnetism)

Full Marks : 40 Time : $2\frac{1}{2}$ Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer all the questions from Selected Option.

OPTION–A

PHY-H-GE-T-01

(Electricity and Magnetism)

GROUP–A

1. Answer any **five** questions: $2\times5=10$

   a) Find the projection of the vector $\vec{A}=\hat{i}-2\hat{j}+\hat{k}$ on the vector $\vec{B}=4\hat{i}-4\hat{j}+7\hat{k}$.

   b) Write the differential form of Gauss's law.

   c) Write the Ampere's Circuital law.

   d) Write the Faraday's laws of electromagnetic induction.

[Turn over]

e) Define magnetic susceptibility and permeability. Write the relationship between them.

f) Write the differences between paramagnetic and ferromagnetic material.

g) Define polarization vector of a dielectric. What is its physical significance?

h) Define Poynting vector? Mention its physical significance.

GROUP–B

2. Answer any **two** questions: 5×2=10

a) Write the Gauss's theorem of electrostatics. Apply this theorem to calculate the electric field at a distance r ($r > a$), due to a uniformly charged infinite cylinder of radius a. 2+3

b) Derive the expression of potential and electric field due to an electric dipole. Define displacement vector. 4+1

c) Write the Biot-Savart's law. Apply this law to find the magnetic field at any axial point of a circular coil carrying a current I. 2+3

d) Show that electrostatic field is conservative. What is magnetic vector potential? 3+2

GROUP–C

3. Answer any **two** questions: $10\times2=20$

a) Write down the relation between B, H and M. What is ferromagnetism? Explain the term 'hysteresis of a magnetic material'. Calculate the mutual force between two straight parallel conductors. each of length l metre in air 2.5 cm apart, when the current in each conductor is 250 Amp. Show that the energy expended in establishing a current 'I' in a coil of self inductance L is $\frac{1}{2}LI^2$. (1+1+2)+3+3

b) Using Gauss's theorem of electrostatics find the electric field at a distance r from the centre of a uniformly charged spherical shell for i) $r > r_2$ and ii) $r \leq r_1$, Where 'r_1' and 'r_2' are the inner and outer radius respectively. Write the Gauss's theorem in dielectrics. Derive an expression of capacitance of a cylindrical capacitor whose inner and outer radii are 'a' and 'b' respectively. 4+2+4

c) An electron moves in a circular orbit 0.51 A^0 around nucleus at a frequency of 6.8×10^{15}Hz. Find the magnetic induction at the nucleus and the equivalent magnetic moment.

Starting from the expression of magnetic vector potential $\vec{A}=\frac{\mu_0 I}{4\pi}\int\frac{\overline{di}}{r}$ obtain the expression $\vec{B}=\frac{\mu_0 I}{4\pi}\int\frac{\overline{di}\times\vec{r}}{r^2}$, where $\vec{B}=\vec{\nabla}\times\vec{A}$. Which law does this expression represent?

If $\vec{F}=4xz\vec{i}-y^2\vec{j}+yz\vec{k}$, evaluate $\iint\vec{F}.\vec{n}\,dS$, where S is the surface of a cube bounded by $x = 0, x = 1, y = 0, y = 1, z = 0, z = 1$.

3+4+3

d) Derive an expression of capacitance of a Parallel plate capacitor completely filled with a composite dielectric. Write the equation of continuity. Explain the concept of Displacement current? Derive the expression of velocity of electromagnetic wave using Maxwell's equations. 3+(2+2)+3

OPTION–B

Course Code : PHY-H-GE-T-03

(Mechanics)

GROUP-A

1. Answer any **five** questions: 2×5=10

a) Show that under Galilean transformation, acceleration of a particle remains invariant.

b) State and prove the work energy theorem.

c) Define radius of gyration for a rigid body rotating about a specified axis.

d) What is Poisson's ratio of a rigid body.

e) Determine the dimension of the coefficient of viscosity of a liquid .

f) Show that the field intensity is perpendicular to the displacement vector in an equipotential surface.

g) Write down the postulates of special theory of relativity.

h) Define Coriolis force with a vector diagram.

GROUP-B

2. Answer any **two** questions: 5×2=10

a) i) Find the general solution of the differential equation $\frac{d^2y}{dx^2}-4\frac{dy}{dx}+5y=0$

ii) Solve: $ydx-xdy-3x^2y^2e^{x^3}dx=0$ 3+2

b) A body of mass m falling from a hight h on a flywheel with radius R. Show that the linear acceleration a of the mass is $,a=\frac{g}{\left(1+\frac{1}{mr^2}\right)}$ (where g is gravitational acceleration) 5

c) Establish the relation among Young's modulus(Y), Rigidity modulus(η) and Poisson's (σ) of a rigid body. 5

d) Calculate the period of a second pendulum measured by an observer travelling at 80% of the speed of light. 5

GROUP-C

3. Answer any **two** questions: 10×2=20

a) i) Considering the differential equation of an orbit derive Newton's law of gravitation.

ii) Show that the angular momentum of a planet revolving round the sun remains constant. 5+5

b) The differential equation for a one dimensional damped harmonic oscillator is given by

$$m\frac{d^2x}{dt^2}+K\frac{dx}{dt}+Sx=0$$

Explain the significance of each term in the equation. Solve the equation for overdamped condition. 2+8

c) i) Prove that $\vec{A}\times\left(\vec{B}\times\vec{C}\right)=\vec{B}\left(\vec{A}.\vec{C}\right)-\vec{C}\left(\vec{A}.\vec{B}\right)$

ii) Prove that central force is conservative.

iii) Show that areal velocity is constant for planetary motion. 4+4+2

d) i) Reduce a two body system to an equivalent one body system.

ii) Three particles of masses 4Kg, 3Kg, and 2Kg are at the points (2, 0, –l), (l, l, 3) and (3, –1, 0) respectively. Find the co-ordinates of the centre of mass.

iii) Write down the necessary and sufficient condition of a first order differential equation to be exact. 5+3+2
