

U.G. 1st Semester Examination - 2020**PHYSICS****[HONOURS]****Generic Elective Course (GE)****Course Code : PHYS-H-GE-T-01(A),(B)**

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****PHYS(H)GE-T-01(A)****(Electricity & Magnetism)****GROUP-A**

1. Answer any **five** questions: $2 \times 5 = 10$
- Show that the electrostatic field of a point charge is irrotational.
 - Write down Maxwell's equations for electromagnetic wave.
 - What do you mean by polarizability of a molecule?

- Define plane polarised light and circularly polarised light.
- What do you mean by magnetic susceptibility?
- Differentiate between dia, para and ferro-magnetic materials.
- State Poynting's theorem.
- What is self and mutual inductances?

GROUP-B

2. Answer any **two** questions: $5 \times 2 = 10$
- Derive the relation among D, E and P.
 - Derive an expression for the self inductance of a long solenoid.
 - Starting from Coulomb's law establish Poisson's equation in electrostatics.
 - Calculate the field and potential due to a dipole of moment \vec{p} . $3+2$

[Turn over]

GROUP-C

3. Answer any **two** questions: $10 \times 2 = 20$
- a) State and explain Biot–Savart’s law. Derive an expression for the magnetic induction at a point on the axis of a current carrying solenoid. $5+5$
- b) Derive the differential equation of electromagnetic wave and hence determine the numerical value of velocity of propagation of electromagnetic wave in free space. $5+5$
- c) Derive the expression of magnetic field due to current carrying circular coil. Find an expression for magnetic field energy density. $5+5$
- d) Find the electric field at internal and external point due to a uniformly charged thin spherical shell. Prove Gauss’s theorem in dielectrics. $5+5$

OPTION-B

PHYS-H-GE-T-01(B)

(Mechanics)

1. Answer any **five** questions: $2 \times 5 = 10$
- a) What do you mean by inertial and non-inertial frames of reference?
- b) What is work-energy theorem?
- c) State and explain the principle of conservation of linear momentum.
- d) What is damped oscillations? Explain with an example.
- e) What is Poisson’s ratio? What is its unit?
- f) Define angular velocity and angular momentum.
- g) Write down the necessary and sufficient condition of a first order differential equation to be exact.
- h) What is GPS?
2. Answer any **two** questions: $5 \times 2 = 10$
- a) i) Find the primitive of the differential equation $y^2 + x^2 \frac{dy}{dx} = \frac{dy}{dx}$.

ii) Find the general solution of the differential equation $\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + x = 0$.

2+3

b) What is torsional pendulum? How will you measure the rigidity modulus of a material using this pendulum? Deduce the necessary formula.

1+4

c) i) Write down the Lorentz transformation formulae and explain time dilation.

ii) A spaceship of rest length 120 m passes an observer on earth in $4.5 \mu\text{s}$. Find its velocity relative to the earth.

3+2

d) Show that the average kinetic and average potential energies of a particle in SHMs are equal. Is restoring force on a SHM conservative? Explain.

4+1

3. Answer any **two** questions: $10 \times 2 = 20$

a) i) Write down the characteristics of motion under central force. Show that the angular momentum is a constant of motion in central force.

ii) A particle moving under a central force describes an orbit given by

$r = a(1 + \cos\theta)$, where a is a constant. Obtain the law of force.

iii) Write down the Kepler's laws of planetary motion. $2+2+3+3$

b) i) Deduce the expression for the torsional rigidity of a specimen in the form of a large cylindrical shell of inner and outer radii r_1 and r_2 .

ii) What is strain energy? Show that the strain energy per unit volume of a stretched wire is $\frac{1}{2} \times \text{stress} \times \text{strain}$.

iii) Draw the stress-strain diagram of an elastic material. $4+(1+3)+2$

c) i) Find the projection of the vector $4\hat{i} - 3\hat{j} + \hat{k}$ on the line passing through the points $(2, 3, -1)$ and $(-2, -4, 3)$.

ii) Prove that $\vec{A} \times (\vec{B} \times \vec{C}) = \vec{B}(\vec{A} \cdot \vec{C}) - \vec{C}(\vec{A} \cdot \vec{B})$.

iii) Find the velocity and acceleration of a particle which moves along the curve $x = 2 \sin 3t$, $y = 2 \cos 3t$, $z = 8t$ at any time $t > 0$. Find also the magnitude of the velocity and acceleration. $3+4+3$

- d) i) Show that the Newton's 2nd law of motion is invariant in an inertial frame of reference. Is it at all possible to have an inertial frame? Explain.
- ii) Define centre of mass of a system of particles. Show that it is a unique point. Prove that the total kinetic energy of a system of particles is equal to the kinetic energy of the centre of mass plus the kinetic energy of the particles with respect to the centre of mass.

(2+2)+(1+2+3)
