

U.G. 1st Semester Examination - 2020

PHYSICS

[PROGRAMME]

Course Code : PHYS-G-CC-T-01(A),(B),(C)

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-G-CC-T-01(A)

(Electricity & Magnetism)

1. Answer any **five** questions: $2 \times 5 = 10$
- a) Write down the Gauss' Law of dielectrics.
 - b) Write down the Laplace's and Poisson equations in electrostatic field.
 - c) Define Electrical susceptibility and Dielectric constant.
 - d) What do you mean by Complex Reactance and Impedance?

- e) Write the Faraday's laws of electromagnetic induction.
- f) Define self inductance and mutual inductance of coils.
- g) What are the Current and Charge Sensitivity, CDR (critical damping resistance) of a Ballistic Galvanometer?
- h) Define Magnetization vector (M) and Magnetic Intensity (H).

2. Answer any **two** questions: $5 \times 2 = 10$

- a) Write the Ampere's Circuital law. Applying this law find the magnetic field inside a toroid. $2+3$
- b) Define displacement current. Write the Maxwell's equations of electromagnetic theory. $1+4$
- c) Find out the expression of Potential and Electric Field of a dipole. Define polarization of a dielectric. $4+1$
- d) Write down the Thevenin theorem and Norton theorem. What is Reciprocity theorem? $2+2+1$

3. Answer any **two** questions: $10 \times 2 = 20$
- a) Using Gauss's theorems of electrostatics find the electric field inside and outside of a uniformly charged sphere. Using the method of Electrical images calculate the potential at any point in space when a point charge is placed in front of a charged infinite sheet. Calculate the Electrostatic energy of a charged sphere.
4+3+3
- b) Derive an expression of capacitance of a cylindrical capacitor completely filled with air. State the Biot-Savart's law and write its mathematical form. What is the physical significance of $\vec{\nabla} \cdot \vec{B} = 0$? Define magnetic vector potential.
4+2+2+2
- c) Write down the relation between B, H and M. What is ferromagnetism? Explain hysteresis in a ferromagnetic material in terms of B-H loop. Show that the hysteresis loss per unit volume per cycle of magnetization is equal to the area enclosed by the B-H loop. Derive an expression of Magnetic force on a current carrying wire.
(1+1+2)+3+3

- d) $V = V_0 \cos \omega t$ is applied to a series LCR circuit.
- i) Find the instantaneous current in the circuit.
- ii) Determine the Value of ω for which the power consumed by the circuit becomes maximum.
- iii) Find the Quality Factor Q of the circuit along with two half-power frequencies. Define bandwidth of the circuit.
- iv) Why the series resonant circuit is called an acceptor circuit? $3+2+3+2$

OPTION-B

PHYS-G-CC-T-01(B)

(Mathematical Physics-I)

1. Answer any **five** questions: $2 \times 5 = 10$

- a) What is the condition of differentiability of a function?
- b) State Uniqueness theorem.
- c) What is integrating factor of a differential equation?
- d) What do you mean by scalar product of two vectors?
- e) Write the form of Laplacian operator in Spherical coordinate.
- f) What is Dirac Delta function?
- g) State Gauss's divergence theorem.
- h) What do you mean by flux of a vector field?

2. Answer any **two** questions: $5 \times 2 = 10$

- a) What do you mean by limit of a function? Show that $\lim_{x \rightarrow 0} \frac{|x|}{x}$ does not exist. $2+3$
- b) What do you mean by Homogeneous and Non-homogeneous differential equation? Find the

roots of the differential equation $y'' - 8y' + 16y = 0$. $2+3$

- c) What is polar vector? If the sides of a triangle can be represented by two vectors show that the area of the triangle be the half of the value of vector product between them. $2+3$
- d) What is cylindrical coordinate system? Calculate the velocity component of a particle in cylindrical coordinate system. $2+3$

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

- a) Find $\lim_{x \rightarrow a} \frac{x^n - a^n}{x - a}$. What do you mean by continuity of a function? If $\sqrt{y+x} + \sqrt{y-x} = c$, then show that $\frac{dy}{dx} = \frac{y}{x} - \sqrt{\left(\frac{y}{x}\right)^2 - 1}$. $4+2+4$

b) Solve any **two** differential equations:

i) $y^2 y' + x^2 = 0$

ii) $xy' = y^2 + y$

iii) $\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + 3x = \sin 3t$ $5+5$

- c) Show that the scalar product of two vectors is invariant under rotation. Find the area of a

triangle by vector method whose vertices are (1,0,1), (2,1,5) and (0,1,2). Show that $\hat{i} \times (\bar{a} \times \hat{i}) + \hat{j} \times (\bar{a} \times \hat{j}) + \hat{k} \times (\bar{a} \times \hat{k}) = 2\bar{a}$.

3+4+3

d) Show that $\bar{E} = \frac{\bar{r}}{r^2}$ is irrotational vector. Evaluate

$\iint (yz\hat{i} + zx\hat{j} + xy\hat{k}) \cdot \bar{dS}$ where S is the surface of the sphere $x^2+y^2+z^2=4$ in the first octant. Find

the value of $\int_0^{\pi} \sin x \delta\left(x - \frac{\pi}{2}\right) dx$. 3+4+3

OPTION-C

PHYS-G-CC-T-01(C)

(Mechanics)

1. Answer any **five** questions: 2×5=10
 - a) Explain ‘inertia’ of a body.
 - b) What do you mean by elastic limit of a body?
 - c) Show that the dimension of work and energy are same.
 - d) What are conservative forces?
 - e) Differentiate between elastic and inelastic collisions.
 - f) State Kepler’s third law of planetary motion.
 - g) Define angle of contact of a liquid with a solid surface.
 - h) What is Galilean transformation?

2. Answer any **two** questions: 5×2=10
 - a) An astronaut feels himself weightless when he stays inside a satellite. Explain the reason. What is a geostationary orbit? 3+2
 - b) Show that a shear θ is equivalent to a compression strain $\theta/2$ and an extension strain $\theta/2$ in two mutually perpendicular directions.

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- c) Calculate the moment of inertia of a solid cylinder about an axis passing through its centre and perpendicular to its own axis of cylindrical symmetry. 5
- d) Define simple harmonic motion (SHM) and derive a relation for velocity and acceleration of a particle executing SHM. 5
3. Answer any **two** questions: 10×2=20
- a) Define 'torque'. Prove the law of conservation of angular momentum. Write short note on GPS. (2+3)+5
- b) Derive Poiseuille's formula for the rate of flow of a liquid through a capillary tube. Explain how this formula is used for determining the viscosity of a liquid by capillary flow method. 6+4
- c) Prove that $Y = 3K(1 - 2\sigma)$ where the terms have their usual meaning. Show that the Poisson's ratio σ of a linear elastic material has values between -1.0 and $+0.5$. 6+4
- d) State the fundamental postulates of special theory of relativity and deduce the Lorentz transformations. 4+6