Total Pages—6

SH PHY —01
(Model Syllabus)

1st Semester Examination, 2021

Time : 3 hours

Full Marks : 60

Answer from **all** the Parts as per direction

The figures in the right-hand margin indicate marks

Candidates are required to answer in their own words as far as practicable

(MATHEMATICAL PHYSICS)

PART – I

1. Answer *all* the questions : 1 × 8

(*a*) The equation $y = x^2$ represents a _____ .

(*b*) $\lim_{x \to 0} \frac{\tan x}{x} =$ _____ .

(*c*) Order of the differential equation

$$1+\left(\frac{dy}{dx}\right)^2 = 6y$$

(*d*) If

$U = e^x \sin y$, then $\frac{\partial u}{\partial x} =$ _____.

(*e*) If $\vec{A} = \hat{i} + x\hat{j} + 5\hat{k}$ and $\vec{B} = 2\hat{i} + \hat{j} - \hat{k}$ are perpendicular, then $x = ?$

(*f*) For any constant '*a*' Dirac delta function $\delta(ax) = ?$

(*g*) For any vector $\vec{A}$ to be Solenoidal,

div $\vec{A}$ = _____ .

(*h*) $\iiint_V \vec{\nabla} \cdot \vec{F} \cdot dv =$ _____.

PART – II

2. Answer any *eight* of the following : $1\frac{1}{2} \times 8$

(*a*) Plot the graph $y = 3x + c$.

(*b*) Find $\lim_{x \to 0} \frac{(1 - x^2)}{x}$.

(*c*) Find the general solution of the differential equation $\frac{d^2y}{dx^2} + 5y = 0$.

(*d*) Give the example of two linearly independent functions.

(*e*) Write the condition of continuity of a function.

(*f*) Solve $ydx - xdy = xy^3dy$.

(*g*) Give the example of two orthogonal vectors.

(*h*) What are the co-ordinates in plane-polar co-ordinates and Draw it.

(*i*) What is the physical meaning of curl of a vector.

(*j*) Give the example where Gauss divergence theorem can be applied.

PART – III

3. Answer any *eight* of the following : 2 × 8

(*a*) Find

$$\lim_{x \to 0} \frac{x^2 + 5x}{x}.$$

(*b*) Find $\frac{dy}{dx}$, if $x = a(t + \sin t)$, $y = a \cos t$.

(*c*) Give the example of a homogenous differential equation. Why it is called so ?

(*d*) Solve the differential equation

$$x\frac{dy}{dx} + y = x^5 + x.$$

(*e*) Define Wronskian. Give an example.

(*f*) Solve the equation $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = e^{3x}$.

(*g*) Evaluate $\lim_{\substack{x \to 0 \\ y \to 0}} \frac{xy}{x^2 + y^2}$.

(*h*) Give the Geometrical interpretation of divergence of a function with an example.

(*Continued*)

(*l*) Define Dirac Delta function. Give one application.

(*f*) State Green's theorem. Give one application.

PART – IV

Answer all questions : 6 × 4

4. Draw the graph $y = \sin^{-1}\left(\frac{1-x^2}{1+x^2}\right)$ and check the continuity and differentiability of the function.

Or

Solve the differential equation

$$\frac{d^2x}{dt^2} - 2\frac{dx}{dt} - 3x = \cos t \, .$$

5. If $U = \frac{y}{z} - \frac{z}{x}$, then find

$$x\frac{\partial u}{\partial x} - y\frac{\partial u}{\partial y} - z\frac{\partial u}{\partial z}.$$

Or

Find the expression for vector tripple product. Give an physical example.

6. Find the expression for velocity in general orthogonal curvilinear co-ordinates. Reduce it to Cartesian Co-ordinates.

Or

Discuss characteristics of a Dirac delta function with physical application.

7. Show that, for two Scalar functions 'f' and 'g' $\nabla f \times \nabla g$ is solenoidal.

Or

State and prove Stoke's theorem.

Total Pages—5

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(MECHANIC)

PART – I

1. Answer *all* questions : 1 × 8

(*a*) What is reduced mass of a two body system having mass m_1 and m_2 ?

(*b*) Moment of inertia is analogous quantity of _____ in linear motion.

(*c*) What is the theoritical limit of poisson's ratio ?

(*d*) Write the relation between gravitational field and potential.

(*e*) For a stream line flow Reynold number is _____ .

(*f*) Time period of a geo-synchronous satellite is _____ .

(*g*) At V = C, time in special theory of relativity is _____ .

(*h*) Einsteins mass energy relation is _____ .

PART – II

2. Answer any *eight* of the following questions : $1\frac{1}{2} \times 8$

(*a*) Define moment of inertia of a body and give its mathematical formula for a continuous system.

(*b*) State the 'principle of conservation of angular momentum.

(*c*) What is Coriolis force ?

(*d*) Give one application of youngs modulus.

(*e*) How the excess pressure inside a Soap bubble changes with surface tension.

(*f*) How the 4-field due to a thin spherical charges with radius.

(*g*) Give one application of a Geo-Synchronous satellite.

(*h*) What is damped oscillation ?

(*i*) How time changes in Gulilean transformation ?

(*j*) What is the postulate of constancy of speed of light in special theory of relativity ?

PART – III

3. Answer any *eight* of the following : 2 × 8

(*a*) With a suitable example explain perpendicular axis theorem of moment of inertia.

(*b*) State and explain Routh rule.

(*c*) Give an example to explain Coriolis force.

(*d*) From the relation between elastic constants estimate practical value of Poisson's ratio.

(*e*) Show that steel is more elastic than rubber.

(*f*) State and explain poiseuille's formula.

(*g*) What are gravity waves ?

(*h*) Calculate the radius of the orbit of a Geo-Synchronous satellite.

(*i*) Explain the condition of resonance.

(*j*) Explain time dilation with an example.

PART – IV

Answer **all** questions : 6 x 4

4. Derive an expression for moment of inertia of a solid sphere about one of its diameters.

Or

What is a non-inertial frame of reference. Calculate the force in that frame.

(*Continued*)

5. Find the expression for bending moment of a light cantilever loaded at one end.

Or

Derive poiseuille's formula for flow of a viscous liquid with end correction.

6. What is central force ? Discuss the motion of a particle in a central force field.

Or

Find the expression for gravitational field on the surface of a solid sphere.

7. What is damped oscillation ? Find the condition of resonance.

Or

With Lorentz transformation equations, discuss length contraction.
