Part-IV

4. a) Solve the differential equation
$(D-2)(D+1)^2y = e^{2x} + e^x$. 6

OR

b) If $x^y + y^x = (x+y)^{x+y}$ find $\frac{dy}{dx}$ at $x = 1, y = 1$.

5. a) State and prove the Euler's Theorem. 6

OR

b) Define vector triple product. Prove that
$\vec{A}\times(\vec{B}\times\vec{C}) = \vec{B}(\vec{A}.\vec{C}) - \vec{C}(\vec{A}.\vec{B})$

6. a) Find expression for Curl in term of orthogonal curvilinear coordinates. 6

OR

b) Define Dirac delta function
Prove that $\delta(x) = \lim_{k\to\infty} \frac{\sin^2 kx}{\pi k x^2}$.

7. a) State and prove that Gauss divergence theorem. 6

OR

b) i) If $\vec{a}$ is a constant vector,
Prove that grad $(\vec{r}.\vec{a}) = \vec{a}$. 3

ii) Find Curl of $\vec{F}$ if $\vec{F} = \frac{x\hat{i} + y\hat{j}}{x+y}$. 3

□□

2021

Full Marks - 60
Time - 3 hours
The figures in the right-hand margin indicate marks
Answer ***all*** questions

Part-I

1. Answer the following : 1×8

a) If $f(x) = |x-1|$ then it is ___ at $x = 2$.

b) Write the integrating factor of $\frac{1}{2}\frac{dy}{dx} + y\tan x = \log 2x$.

c) $\vec{a}\times(\vec{b}\times\vec{c}) = (\vec{a}.\vec{c})\vec{b} -$ ___

d) Write the condition for vector $\vec{A}$ and $\vec{B}$ are to be perpendicular.

e) If $\vec{\nabla}\times\vec{A} = 0$, then $\vec{A}$ is a ___.

f) $\delta(ax) = \frac{1}{|a|}$ ___.

g) What is the value of $\vec{\nabla}.\vec{r}$?

h) Write the mathematical form of Green's theorem in plane.

Part-II

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

a) Prove that the position vector of a point is not selenodial.

b) Check if $f(x) = |x - 2|$ is continuous at $x = 2$.

c) Find particular integral of $\frac{d^2y}{dx^2} + y = \cos x$.

d) Solve $(2x + y)dy - (x + 2y)\,dx = 0$

e) Prove that $\left(\vec{a}.\vec{b}\right)^2 + \left(\vec{a} \times \vec{b}\right)^2 = a^2b^2$.

f) For what value of x the vector $\vec{A} = x\hat{i} + 2\hat{j} + 3\hat{k}$ and $\vec{B} = 2\hat{i} + x\hat{j} - 4\hat{k}$ are orthogonal.

g) Find grade ϕ if $\phi = \sqrt{x^2 + y^2 + z^2}$.

h) Prove that $\delta(-x) = \delta(x)$.

i) If $x = r\cos\theta$, $y = r\sin\theta$

Find $\frac{\partial(x,y,z)}{\partial(r,\theta,z)}\beta$.

j) Prove that $\vec{\nabla}.(\vec{u}v) = \vec{u}.\vec{\nabla}v + v(\vec{\nabla}.\vec{u})$.

Part-III

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

a) Prove that $(2xy + 3)\,dx + (x^2 - 4y)dy = 0$ is an exact differential equation.

b) Find the approximate value of 9.9967.

c) State the condition of differentiability of $f(x)$ at $x = x_0$.

d) Find the value of $\lim_{\substack{x\to 1\\ y\to 2}} \frac{2x^2y}{x^2 + y^2 + 1}$.

e) Show that $\hat{i} \times (\vec{a} \times \hat{i}) + \hat{j} \times (\vec{a} \times \hat{j}) + \hat{k} \times (\vec{a} \times \hat{k}) = 2\vec{a}$

f) If $\vec{A} + \vec{B} + \vec{C} = 0$ prove that

$\vec{A} \times \vec{B} = \vec{B} \times \vec{C} = \vec{C} \times \vec{A}$

g) Express the value of $\vec{\nabla}u$, $\vec{\nabla}v$ and $\vec{\nabla}w$ in terms of h_1, h_2, h_3 and unit vector $\hat{e}_1, \hat{e}_2, \hat{e}_3$.

h) Solve $xdx + ydy + 2(x^2 + y^2)dx = 0$.

i) Evaluate $\int_{-1}^{+1} 4x^2\delta(2x + 1)dx$.

j) Prove that

$\text{div}(\vec{a}.\vec{b}) = \vec{b}.\vec{\nabla} \times \vec{a} - \vec{a}.\vec{\nabla} \times \vec{b}$.

Part-IV

4. a) State parallel axis theorem. Find expression for moment of inertia of a solid cylider about the axis passing through its own axis of symmetry. 6

OR

b) Explain non inertial frame of Reference and Fictious force. Find the expression for total force and fictitious force acting on a body in non-inertial frame of reference.

5. a) Derive an expression for depression produced in a single cantilever at it's free end. 6

OR

b) Derive the relation between elastic constant (γ, β, η).

6. a) What is central force ? Obtain equation of motion and first integral. 6

OR

b) Explain the reduced mass of two body problem. Its reduced mass is always smaller than either of masses.

7. a) Derive expression for total energy of a particle executing S.H.M. Find the distance from mean position where K.E. is $\frac{1}{2}$ potential energy. 6

OR

b) Derive Lorentz transformation equation.

2021

Full Marks - 60

Time - 3 hours

The figures in the right-hand margin indicate marks

Answer *all* questions

Part-I

1. Answer the following : 1×8

a) State the direction of Torque.

b) Define Non inertial frame.

c) State Hooke's law of elasticity.

d) Write unit and dimension of co-efficient of Viscosity.

e) Kepler's 3rd law in known as ____ law.

f) GPS statellites carry atomic clocks with them. (True/false)

g) Draw graph of energy verses displacement for body in SHM.

h) Write the relativistic energy momentum relation.

Part-II

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

a) Prove law of conservation of angular momentum of particle.

b) Define a flywheel.

c) Explain laboratory frame of reference.

d) Find the torque of force $\vec{F} = \left(-\hat{i} - 3\hat{j} + \hat{k}\right) N$ about a point (1m, 1m,1m) when the force act at point P(2m, 3m, 4m).

e) Prove that Workdone in elongation a wire is $\frac{1}{2} \times$ load × elongation.

f) Calculate the horizontal force required to move plate of area $150cm^2$ kept on the upper surface of viscous liquid of thickness 3mm flowing at a speed 5cm/s.

g) If central force is $\vec{F} = \frac{-k\vec{r}}{r^3}$. Find its potential energy.

h) How an astronaut feels weightless in a satellite.

i) Explain critical damping.

j) Write equation for time dilation.

Part-III

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

a) A body mass 15gm appears 20gm when in motion, find its velocity.

b) Find the length of Second's pendulum.

c) Explain Pseudo-force with examples.

d) Two bodies of masses 3kg and 5kg are located at point (1, 2) and (–1, 3) respectively. Calculate the coordinate of centre of mass.

e) Discuss the variation of viscocity of liquids and gases with rise in temperature.

f) Explain GPS.

g) Prove that Kepler's 2nd law from conservation of angular momentum of central force motion.

h) Derive relation between graviational potential and graviational field.

i) Derive torque is term of mement of intertia of a body.

j) State postulates of special theory of relativity.

Part-IV

4. a) Solve the differential equation
$(D-2)(D+1)^2y = e^{2x} + e^x$. 6

OR

b) If $x^y + y^x = (x+y)^{x+y}$ find $\frac{dy}{dx}$ at $x = 1, y = 1$.

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□□

2021

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d) Write the condition for vector $\vec{A}$ and $\vec{B}$ are to be perpendicular.

e) If $\vec{\nabla}\times\vec{A} = 0$, then $\vec{A}$ is a ___.

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g) Express the value of $\vec{\nabla}u$, $\vec{\nabla}v$ and $\vec{\nabla}w$ in terms of h_1, h_2, h_3 and unit vector $\hat{e}_1, \hat{e}_2, \hat{e}_3$.

h) Solve $xdx + ydy + 2(x^2 + y^2)dx = 0$.

i) Evaluate $\int_{-1}^{+1} 4x^2\delta(2x + 1)dx$.

j) Prove that

$\text{div}(\vec{a}.\vec{b}) = \vec{b}.\vec{\nabla} \times \vec{a} - \vec{a}.\vec{\nabla} \times \vec{b}$.

MODEL QUESTION

MATHEMATICAL PHYSICS

1. A matrix is given by $M = \frac{1}{\sqrt{2}}\begin{bmatrix} i & 1 \\ 1 & i \end{bmatrix}$. The eigenvalues of M are
   a. real and positive
   b. purely imaginary with modulus 1
   c. complex with modulus 1
   d. real and negative
2. The product PQ of any two real, symmetric matrices P and Q is
   a. symmetric for all P and Q
   b. never symmetric
   c. symmetric, if PQ=QP
   d. anti-symmetric for all P and Q
3. Which of the following is INCORRECT for the matrix $M=\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$?
   a. It is its own inverse
   b. It is its own transpose.
   c. It is non-orthogonal
   d. It has eigen values ± 1
4. f(x) is a periodic function of x with a period of 2π. In the interval -π<x<π ,f(x) is given by

$$f(x) = \begin{cases} 0 & -\pi < x < 0 \\ \sin x & 0 < x < \pi \end{cases}$$

In the expansion of f(x) as a Fourier series of sine and cosine functions, the coefficient of cos 2x is:

   a. $\frac{2}{3\pi}$
   b. $\frac{1}{\pi}$
   c. 0
   d. $-\frac{2}{3\pi}$
5. The phase of the complex number (1+i)i in polar representation is:
   a. $\frac{\pi}{4}$
   b. $\frac{\pi}{2}$
   c. $\frac{3\pi}{4}$
   d. 0
6. For the given set of equations

$$x + y = 1, y + z = 1, z + x = 1$$

which one of the following statements is correct?
   a. Equations are inconsistent
   b. Equations are consistent and a single non-trivial solution exists
   c. Equations are consistent and many solutions exist
   d. Equations are consistent and only a trivial solution exists.

7. The tangent line to the curve $x^2 + xy + 5 = 0$ at (1,1) is represented by:
   a. $y = 3x - 2$
   b. $y = -3x + 4$
   c. $x = 3y - 2$
   d. $x = -3y + 4$
8. For the Fourier series of the following function of period 2π,

$$f(x) = \begin{cases} 0, & -\pi < x < 0 \\ 1, & 0 < x < \pi \end{cases}$$

   the ratio (to the nearest integer) of the Fourier coefficients of the first and the third harmonic is:
   a. 1
   b. 2
   c. 3
   d. 6
9. Let $f(x) = x^3 - 2y^3$, the curve along which $\nabla^2 f = 0$ is
   a. $x = \sqrt{2}\, y$
   b. $x = 2y$
   c. $x = -2y$
   d. $x = -\sqrt{2}\, y$.
10. If θ (x,y,z) is a scalar function which satisfies the Laplace equation, then the gradient of θ is
   a. *Solenoidal and irrotational*
   b. Solenoidal but not irrotational
   c. Irrotational but not solenoidal
   d. Neither Solenoidal nor irrotational

UG-Phy-CC-II

MODEL QUESTION

Full marks-60

Time-3hours

Answer all the questions

Part-I

[1× 8]

1. Answer_the_following_question

a) The angular momentum of a particle having moment of inertia 1 and angular velocity ω is equal to .....
Ans-1ω

b) A wire can bear a load of 30kg without breaking. If the wire is cut into two equal parts, each part can bear a maximum load of .....
Ans-30kg

c) The centre of mass of system of two particles of masses m1 and m2 lie on .....
Ans-m2

d) A particle is moving in a circle with uniform speed. its motion is .....
Ans-periodic but not simple harmonic

e) The moment of inertia of a particle depends on which factor?
Ans-axis of rotation

f) The particle is rotating at speed of 900 rev/min about its axis. if it comes to rest in 1 min, then what is angular retardation?
Ans-π/2 rad/s^2

g) A spiral spring is stretched by a weight attached to it. what will be the strain?
Ans-shear

h) What is the phase difference between velocity and displacement of a particle executing S.H.M.?
Ans-$\frac{\pi}{2}$

PART-II

2. **Answer any 8 of the following questions.** [1.5x8]

a) What is the relation between linear vector and angular vector of a particle rotating about a point?
Ans-$v = w \times r$

b) What is meant by pseudo force? give an example.
Ans-The force which arises due to acceleration of frame is called pseudo force. Eg-centrifugal force.

c) Can you measure the moment of inertia of the compound pendulum by oscillation method?
Ans-Yes. $I = MK^2$

d) State Hooke's law.
Ans-Hooke's law states that within elastic limit, stress is proportional to strain.

e) Why is steel more elastic than rubber?
Ans-Because steel has greater moduli of elasticity than rubber.

f) In the language of physics which is more elastic out of air and water?
Ans-water

g) What type of modulus of elasticity is involved in twisting of a cylinder?
Ans-Modulus of rigidity

h) State the condition under which the torque acting on the particle can be zero.
Ans-When line of action of force passes through the origin.

i) Does the particle undergoing simple harmonic motion attain maximum displacement and maximum velocity at the same time?
Ans-No

j) Which quantity is conserved during oscillation in SHM?
Ans-Mechanical energy of harmonic oscillator.

PART-III

3. Answer any 8 of the following questions. [2x8]

a) Find the moment of inertia of a circular ring about the diameter.
Ans-$\frac{1}{2}MR^2$

b) State Routh's rule.

c) Write down the Newton's laws of gravitation.

d) The radius of a cable is doubled and its length is halved. what effect will it have on the maximum load which the cable can support?
Ans-$Y = \frac{Fl}{A\Delta l}$

e) Explain surface tension.

f) Find the work done in elongating wire.
Ans-W=$\frac{1}{2}$Fl=$\frac{1}{2} \times stress \times strain$

g) State the Kepler's law.

h) What is the shape of graph between velocity and displacement of a particle executing S.H.M. on x-axis?
Ans-$\frac{v^2}{wA^2} + \frac{x^2}{A^2} = 1$
Ellipse

i) Explain Damped Harmonic Oscillator.

j) State the postulates of special theory of relativity.

PART-IV

Answer all the following questions. [6x4]

4. Find torque acting on a rigid body and also find the relation between force and torque.

Or

(h) Write the differential equation for heat flow .

Ans-$\frac{du}{dt} = c^2 \frac{d^2u}{dx^2}$

(i) What is the time constant of a I.R circuit of a L.R circuit and its significance.

Ans-T=$\frac{L}{R}$

(j) How an inductor used as filter?

Ans-Inductor blocks AC and provides zero resistance to DC.

PART-III

3. Answer any eight of the following questions. 2x8

(a) State and explain parallel axis theorem of moment of inertia.
(b) Find the gravitational field near a thin spherical cell.
(c) State and explain Poiseuilles formula.
(d) What is resonance? Explain with an example.
(e) What are Lissajous figure?
(f) How entropy changes in an irreversible process?
(g) State and explain Amperes circuital Law.
(h) Derive 1st Maxwell thermodynamic relation.
(i) State and explain Biot-Savart's Law.
(j) Explain working of a R-C filter.

PART-IV

Answer all questions. 6x4

4. Find the expression for gravitational potential and field at an external point of a solid sphere.

Or

Define elastic constants. Find a relation among them.

5. With exact equations, discuss condition uf damped harmonic motion.

Or

Draw and discuss Lissajous figure of two component waves of frequency 2:1.

6. Discuss working of a Carnot Engine. Derive expression for its efficiency.

Or

Derive Clausius-Claperon equation.

7. Using Biot-Savarts Law find the magnetic field near a long straight conduction.

Or

Discuss working of full wave Bridge Rectifier. What is its efficiency?

MODEL QUESTION

Full marks-60

Time-3hours

Answer all the questions

Part-I

1. Answer the following questions . 1x8

(a) What is the moment of inertia of a solids sphere about an axis passing through its center?

Ans-$\frac{2}{5}MR^2$

(b) Write the relation between Y,K and σ (elastic constant).

Ans-$K = \frac{Y}{3(1-2\sigma)}$

(c) In **S.H.M ,F α .....**?

Ans-x(displacement)

(d) How velocity of a longitudinal wave depends upon density of the medium?

Ans-v α $\frac{1}{\sqrt{\rho}}$,ρ=density

(e) Entropy remains ..... in a reversible process.

Ans-unchanged

(f) What is the absorptivity of a perfect black body?

Ans-1

(g) What are the majority charge carrier in p-type semiconductor?

Ans-holes

(h) What is the ripple factor of Half wave rectifier?

Ans-1.21

PART-II

2. Answer any eight of the following questions. 1.5x8

(a) Write the relation between gravitational field and potential.

Ans-G=-$\frac{dV}{dr}$

(b) What is moment of inertia of a cylinder about its axis of symmetry?

Ans-$\frac{1}{2}MR^2$

(c) Write the S.I unit and dimensional formula for coefficient of viscosity.

Ans-Poise, $ML^{-1}T^{-1}$

(d) What is damped harmonic oscillation?

(e) How velocity of a transverse wave changes by doubling tension(T)?

Ans-Increases by$\sqrt{2}$ times.

(f) Draw the p-v diagram for a Carnot Engine.

(g) State Gauss law in Electrostatics.

MODELQUESTION

Full marks-

60Time-

3hours

Answer all the questions

Part-I

1. Answerthefollowingquestions [1x8]

a) What is radius of gyration?
b) Write the unit of coefficient of elasticity?
c) What is the energy-momentum relation in photon?
d) The rest mass of photon is_____ .
e) The expression for escape velocity is _____.
f) What is viscous flow of liquid?
g) Write the dimension of moment of inertia?
h) The value of 'g' is minimum at _____ .

PART-II

2. Answerany8ofthefollowing questions. [1.5x8]

a) State perpendicular axis theorem?
b) What is coriolis force?
c) Discuss the difference between inertial and non inertial frame of reference.
d) What is ampilitude reasonance and write the expression for it?
e) What is the basic difference between viscous flow and streamlined flow.
f) Why a hollow beam is stronger than a solid beam?
g) What is centre of mass?
h) Give an example of reduction of two body problem to one body problem.
i) Write the expression for relativistic momentum?
j) In which region the velocity of pendulum bob is maximum?

PART-III

3. Answer any 8 of the following questions. [2x8]

a) The value of Poisson's ratio lies between _____and _____.
b) What is surface tension ? How is it measured?
c) How average kinetic energy is related to total energy in S.H.M. ?
d) Prove that $E^2=P^2c^2+m^2c^4$?
e) What is critical velocity?
f) Show that Q-factor represents the change in phase during which the energy of damped oscillator reduces to 1/e times of its initial value.
g) What is the difference between a simple and compound pendulum?
h) Prove that, energy density= ½(stress x strain)?
i) Write the postulates of special theory of relativity?

j) What are Kepler's law of planetary motion ?

PART-IV

Answer all the following questions. [6x4]

4. Derive an expression for relation between elastic constants.

Or

Derive Poissuelie's formula for the rate of flow of liquid through a tube.

5. Derive an expression for moment of inertia of an annular disc about a tengent.

Or

State and prove parallel and perpendicular axis theorem.

6. What is damped vibration and derive an expression for differential equation of damped vibration.

Or

Show that average kinetic energy is equal to average potential energy in S.H.M.

7. What is nuclear reaction? Give examples. What is meant by Q-value of nuclear reaction?

Or

Discuss Michelson Morley experiment on the basis of theory of relativity.

Explain the effect of centrifugal and Coriolis force due to rotation of earth and also explain their effect on 'g' of earth.

5. Derive the expression for depression of the beam for a light cantilever.

Or

State and derive Poiseuille's equation for flow of liquid.

6. Define and explain Gravitational potential energy.

Or

Derive an expression for energy equation in central force motion.

7. What is damped oscillation? Derive an expression for differential equation of a damped harmonic oscillator and also find its solution.

Or

Explain Length contraction and Time dialation.