TDC (CBCS) Odd Semester Exam., 2018

PHYSICS

(1st Semester)

Course No. : PHSHCC-101T

(Mathematical Physics—I)

Full Marks : 50

Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer **all** questions

UNIT—I

1. Explain any *two* of the following with examples : 2×2=4

(a) Hermitian matrix

(b) Orthogonal matrix

(c) Unitary matrix

2. Answer *(a) or (b)* :

(a) Find the eigenvalues and eigenvectors of the following matrix : 6

$$\begin{bmatrix} 2 & 0 & 1 \\ 0 & 2 & 0 \\ 1 & 0 & 2 \end{bmatrix}$$

(b) (i) Find the integrating factor and hence solve the differential equation

$$\frac{dy}{dx} + xy = 2x$$ 3

(ii) Solve the differential equation

$$9\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + y = 0$$

Also find its Wronskian to show that its two solutions are independent. 3

UNIT—II

3. Answer any *two* questions : 2×2=4

(a) If

$$|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$$

show that $\vec{A}$ and $\vec{B}$ are mutually perpendicular.

(b) Find the unit vector perpendicular to each of the vectors $\vec{A} = 2\hat{i} - \hat{j} + \hat{k}$ and $\vec{B} = 3\hat{i} + 4\hat{j} - \hat{k}$.

(c) A particle moves from point (4, −3, −5) metre to point (−1, 4, 3) metre under the action of force $\vec{F} = (-3\hat{i} - \hat{j} + 2\hat{k})$ *N*. Find the work done by the force.

4. Answer (a) and (b) *or* (c) and (d) :

(a) Show that the scalar product of two vectors is invariant under the rotation of coordinate axes. 3

(b) Prove that

$$\vec{A} \times (\vec{B} \times \vec{C}) + \vec{B} \times (\vec{C} \times \vec{A}) + \vec{C} \times (\vec{A} \times \vec{B}) = 0$$ 3

(c) What is the gradient of a scalar point function? Give its geometrical interpretation. 2+2=4

(d) Show that

$$\vec{F} = (x+3y)\hat{i} + (y-3z)\hat{j} + (x-2z)\hat{k}$$

is a solenoidal vector. 2

UNIT—III

5. Answer any *two* questions : 2×2=4

(a) Use polar coordinates to evaluate the surface integral $\iint (x^2 + y^2)\,dx\,dy$ over the first octant of the circle $x^2 + y^2 = a^2$.

(b) Find the total mass of the body in the region $0 \le x \le 2$, $0 \le y \le 2$, $0 \le z \le 2$ with density function $\sigma(x, y, z) = xyz$.

(c) Find the directional derivative of $\phi = x^3 + y^3 + z^3$ at the point (1, −1, 2) in the direction of the vector $\hat{i} + 2\hat{j} + \hat{k}$.

6. Answer *(a)* or *(b)* :

(a) State and prove Gauss' divergence theorem. 6

(b) Verify Stokes' theorem for the vector $\vec{A} = (3x-2y)\hat{i} + x^2 z\hat{j} + y^2(z+1)\hat{k}$ for a plane rectangular area having vertices at (0, 0), (1, 0), (1, 2), (0, 2) in the *xy*-plane. 6

UNIT—IV

7. Answer any *two* questions : 2×2=4

(a) What is orthogonal curvilinear coordinate system?

(b) Write the expression for gradient of a scalar in orthogonal curvilinear coordinates.

(c) Write the expression for line element and volume element in orthogonal curvilinear coordinates.

8. Answer *(a)* or *(b)* :

(a) Derive the expression for divergence of a vector in terms of orthogonal curvilinear coordinates. 6

(b) What is cylindrical coordinate? Derive the expression for gradient of a scalar in cylindrical coordinate system. 6

UNIT—V

9. Answer any *two* questions : 2×2=4

(a) Marks obtained by the students of a class of 30 numbers out of total 100 marks are as given below :

Marks obtained	*No. of students*
60	4
70	6
80	3
85	7
90	8
95	2

Find the mean, median and mode of the above given data.

(b) Find the standard deviation of the following set of data :

4, 6, 8, 4, 10

(c) Write the probability distribution function for a binomial variate. Under which condition, binomial distribution tends to Poisson's distribution?

10. Answer *(a)* or *(b)* :

(a) Find the expression for mean and standard deviation of binomial distribution. 6

(b) Show that mean and variance are equal in Poisson's distribution. 6

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2018/TDC/ODD/PHYC–102T/055

TDC (CBCS) Odd Semester Exam., 2018

PHYSICS

(1st Semester)

Course No. : PHSHCC–102T

(Mechanics)

Full Marks : 50
Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer **all** questions

UNIT—I

1. Answer any *two* questions of the following : 2×2=4

(a) Explain reference frames and Galilean transformations.

(b) Explain, in brief, conservative and non-conservative forces.

(c) Two particles of masses 100 g and 300 g have at a given time position vectors $(2\hat{i}+5\hat{j}+13\hat{k})\,m$ and $(-6\hat{i}+4\hat{j}-2\hat{k})\,m$ respectively. Find the position vector of centre of mass.

2. Answer either *(a)* and *(b)* or *(c)* and *(d)*.

(a) Show that whereas length and acceleration are invariant with respect to Galilean transformation, velocity is not. 3

(b) Prove that in centre of mass system, the magnitude of the velocities (or speeds) of the particles remain unaltered in elastic collision. 3

(c) Establish the law of conservation of linear momentum with the help of Galilean invariance. 3

(d) What is the potential energy curve of a particle? From a potential energy curve, explain the terms, states of stable and unstable equilibrium. 3

UNIT—II

3. Answer any *two* questions of the following :

(a) Show that the time rate of change of angular momentum of a particle is equal to the torque acting on it. 2

(b) Explain, in brief, rigidity modulus and Poisson's ratio. 2

(c) Two solid cylinders of the same material having lengths l and $2l$ and radius r and $2r$ respectively are joined coaxially. Under a couple applied between free ends, the shorter cylinder shows a twist of 30°. Calculate the twist of large cylinder. 2

4. Answer either *(a)* and *(b)* or *(c)* and *(d)*.

(a) Show that angular momentum $\vec{L}$ of a system of particles about a point can be expressed as

$$\vec{L} = \vec{L}_{CM} + \vec{R}_{CM} \times M\vec{V}_{CM}$$ 3

(b) If Y, K and σ represent Young's modulus, bulk modulus and Poisson's ratio respectively, then show that

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

(c) State the theorems of parallel and perpendicular axes of moment of inertia. 2

(d) A cylinder of length l and of radius a is clamped at one end and a torque is applied at the other end. Establish the restoring torque that comes to play

during the twisting of the cylinder is given by

$$\tau = \frac{\pi \eta a^4}{2l} \varphi$$

when η is the modulus of rigidity and φ is the angle of twist. 4

UNIT—III

5. Answer any *two* questions :

(a) Define inertial mass and gravitational mass. 2

(b) Calculate the gravitational potential on the surface of earth using the following data : 2

Radius of the earth = $6 \cdot 37 \times 10^8$ cm

Mean density of earth = 5·53 g

Gravitational const. = $6 \cdot 66 \times 10^{-8}$ CGS units

(c) Describe in brief global positioning system (GPS). 2

6. Answer either (*a*) and (*b*) or (*c*) and (*d*) :

(a) Obtain an expression for gravitational potential due to a solid sphere at a point outside the sphere. What will be the potential when the point lies on the surface of the sphere? 3

(b) Explain in brief how a satellite may be placed in its orbit round the earth and find an expression for its orbital velocity. 3

(c) Show how two-body problem under central forces can always be reduced to the form of one-body problem. 3

(d) State Kepler's laws of planetary motion and using the deductions from Kepler's laws, show that the force of attraction between the sun and the planet is directly proportional to the product of their masses. 3

UNIT—IV

7. Answer any *two* questions :

(a) Explain the term resonance in connection with forced oscillations. 2

(b) Write the differences between inertial and non-inertial frames of references. 2

(c) Calculate the displacement to amplitude ratio in case of SHM, when the KE is 90% of total energy. 2

8. Answer either *(a)* and *(b)* or *(c)* and *(d)*.

(a) Show that the time period of a simple harmonic oscillator is given by

$$T = 2\pi\sqrt{\frac{\text{displacement}}{\text{acceleration}}}$$ 3

(b) What is Coriolis force? Under what conditions does it come into play? 3

(c) Write down differential equation of damped vibration and solve it to find the general equation of displacement. 3

(d) State the components of velocity and acceleration in cylindrical coordinate system. 3

UNIT—V

9. Answer any *two* questions :

(a) A particle of mass 10^{-24} kg is moving with a speed of $1\cdot 8\times 10^{8}\,\text{ms}^{-1}$. Calculate its mass when it is in motion. 2

(b) Explain in brief the outcome of Michelson-Morley experiment. 2

(c) Write a short note on relativistic doppler effect. 2

10. Answer either *(a)* and *(b)* or *(c)* and *(d)*.

(a) Write down Lorentz transformation equation and show that for ordinary speed, Lorentz transformation equation reduces to Galilean transformation. 2

(b) Deduce Einstein's formula for addition of velocities. 4

(c) What do you understand by time dilatation? Explain the term proper time in connection with the theory of relativity. 2

(d) Deduce Einstein's mass-energy relation. 4

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