No. of Printed Pages : 4 Sem-I-Phy-CC-1(R&B)

2021

Time - 3 hours

Full Marks - 60

*Answer **all groups** as per instructions.*
Figures in the right hand margin indicate marks.
Candidates are required to answer
in their own words as far as practicable.

GROUP – A

1. Answer all questions and fill in blanks as required. [1 × 8

(a) $\lim_{x \to 0} \frac{\sin x}{x} =$ _____.

(b) If $y_1(x)$ and $y_2(x)$ are linearly dependent, then what should be value of their Wronskian $w(y_1, y_2)$?

(c) Name the type of differential equation $\frac{dy}{dx} = \frac{f(x,y)}{\phi(x,y)}$.

(d) Find value of $\hat{i} \times (\hat{j} \times \hat{k})$.

(e) Find the order of differential equation $\frac{d^2y}{dt^2} = k^2 \frac{dy}{dt}$.

(f) If position vector of a point 'P' is $\mathbf{r} = \mathbf{r}(u.v.w)$ then scale factors h_1 = _____, h_2 = _____ and h_3 = _____.

P.T.O.

(g) $\delta[(x-a)(x-b)] =$ _____.

(h) If $\nabla \times \mathbf{A} = 0$, then what is the one value of $\phi \mathbf{A} \cdot \hat{n}\, ds$?

GROUP – B

2. Answer any eight of the following questions within two to three sentences each. [1½ × 8

(a) State the condition for differential equation
$M(x \cdot y)\, dx + N(x \cdot y)\, dy = 0$ to be exact.

(b) Write down Taylor series of f(x) about the point x = a.

(c) What do you mean by flux of a vector ?

(d) Find div **r**.

(e) Find Integrating factor of $y' + 5y = 3e^x$.

(f) What are vector and scalar fields ?

(g) Find the value of $\frac{\partial^2 u}{\partial x\, \partial y}$ if $u = x^2 + y^2$.

(h) Write Dirac delta function in integral form.

(i) Show that $\nabla \times \mathbf{r} = 0$.

(j) Complete the vector identity $\nabla \times \nabla \times \mathbf{A} =$ _____.

GROUP – C

3. Answer any eight of the following questions within 75 words each. [2 × 8

(a) Find value of m if $\mathbf{A} = \hat{i} + \hat{j} + 5\hat{k}$ and $\mathbf{B} = 2\hat{i} + m\hat{j} - \hat{k}$ are perpendicular to each other.

(b) State uniqueness theorem.

(c) If the edges of a parallelepiped are $2\hat{i} - 3\hat{j} + 4\hat{k}$, $\hat{i} + 2\hat{j} - 2\hat{k}$ and $-3\hat{i} + 2\hat{j} - \hat{k}$ then find its volume.

(d) Show that $\delta(ax + b) = \frac{1}{|a|}\,\delta\left(x + \frac{b}{a}\right)$.

(e) Find a unit vector perpendicular to surface $x^2 + y^2 + z^2 = 7$ at the point (2, 3, 4).

(f) State Stoke's theorem.

(g) Express operator ∇ in cylindrical coordinate.

(h) Find $\nabla\phi.d\mathbf{r}$ where $\phi(x, y, z)$ is a constant.

(i) If **a** is a constant vector, then show that grad $(\mathbf{r} \cdot \mathbf{a}) = \mathbf{a}$.

(j) Using Stoke's theorem, prove

$$\int_C \mathbf{r}.d\mathbf{r} = 0 \text{ where } \mathbf{r} = x\hat{i} + y\hat{j} + z\hat{k}.$$

GROUP – D

*Answer **any four** questions within 500 words each.*

4. (a) Find the appropriate value of $(122)^{1/3}$ using differential calculus. [3

   (b) Solve the differential equation $x\frac{dy}{dx} + y = x^3 + x$. [3

5. (a) Solve the differential equation $y'' - 5y' + 6y = 0$. [3

   (b) If $y_1(x) = e^x$ and $y_2(x) = e^{-2x}$, show that they are linearly independent. [3

6. Using Lagrange's method, find out the minimum value of $x^2 + y^2 + z^2$, when $xyz = a^3$. [6

7. If $\mathbf{A} = \hat{i} - 2\hat{j} + 3\hat{k}$, $\mathbf{B} = -2\hat{i} + 3\hat{j} - 4\hat{k}$ and $\mathbf{C} = \hat{i} - 3\hat{j} + 5\hat{k}$ then check whether they are coplanar or not. [6

8. Prove that cylindrical coordinate system is orthogonal. [6

9. Evaluate $\int_{-1}^{+1} 9x^3 \delta(3x+1)\,dx$. [6

10. Find the directional derivative of $f = xyz$ at $(-1, 1, 3)$ along $\mathbf{a} = \hat{i} - 2\hat{j} + 2\hat{k}$. [6

11. State and prove Gauss divergence theorem. [6

No. of Printed Pages : 4

Sem-I-Phy-CC-2(R&B)

2021

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GROUP – A

1. Answer all questions and fill in blanks as required. [1 × 8

(a) Under which condition the angular momentum of a particle be zero.

(b) What is the value of momentum of inertia of a sphere about its diameter when the sphere contracts to half in its radius.

(c) The value of Poisson's ratio should always be _____.

(d) Write down the Dimensional formulae of 'Kinematic Velocity'.

(e) For elliptical path the eccentricity should be _____.

(f) What is the value of 'G' in MKS system.

(g) Define 'stiffness'.

(h) What is the speed of a particle with zero rest mass ?

P.T.O.

GROUP – B

2. Answer any eight of the following questions within two to three sentences each. [1½ × 8

(a) Write the components of angular momentum of a particle in vector form.

(b) State 'Routh Law' for the MI of spherical bodies.

(c) State and define 'Radius of gyration' of a body.

(d) Define 'flexural rigidity' of a beam.

(e) What is 'Center of Percussion' ?

(f) Write the basic difference between a Geostationary satellite and Geosynchronous satellite.

(g) Write the relation between time-average values of K.E. and P.E. of a body in SHM.

(h) How is relaxation time related with resistance constant ?

(i) Write down the postulates of special theory of relativity.

(j) Explain the physical significance of Michelson-Morley experiment.

GROUP – C

3. Answer any eight of the following questions within 75 words each. [2 × 8

(a) State and prove the law of Conservation of angular momentum.

(b) State and Establish Parallel axis theorem of rotational bodies.

(c) Derive an expression of K.E. in rotational motion.

(d) A couple of 20 Nm is applied to a fly-wheel of mass 10 kg and radius of gyration 0.5 m. Find the resultant angular acceleration.

(e) What is Coriolis force ? How its effect observe in formation of cyclone ?

(f) Proof that a central force is a conservative force.

(g) Proof that in an elliptical orbit, total energy depends only on the semi-major axis of the orbit.

(h) Find the time average value of kinetic and potential energy over a period 'T' of a particle executing S.H.M.

(i) What is quality factor (q) in damping and what will be its value in case of light damped harmonic oscillator.

(j) Explain and deduce an expression of time dilation in relativity.

GROUP – D

*Answer **any four** questions within 500 words each.*

4. Derive an expression for the moment of inertia of a solid cylinder about its axis of symmetry. [6

5. Deduce an expression for couple per unit twist of an uniform solid cylinder. [6

6. Derive Poiseuille's formulae for the rate of flow of liquid through a tube. [6

7. Deduce the differential equation of the orbit for a particle moving under central force. [6

8. What is meant by a damped harmonic oscillator ? Write the differential equation and find its solution. [6

9. Derive Einstein's mass-energy relation. [6

10. Obtain a relation between Young's modulus, bulk modulus and Poisson's ratio in elasticity. [6

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GROUP – A

1. Answer all questions and fill in blanks as required. [1 × 8

(a) What is value of 'G' in m.k.s. system ?

(b) Write the dimensional formula of kinematic viscosity.

(c) The value of Poisson's ratio lies in between _____ and _____.

(d) Damping tends to _____ the time period of the vibrating body.

(e) Does the efficiency of an engine depend on nature of working substance ?

(f) Is electric flux a scalar or a vector quantity ?

(g) Can power factor be ever equal to one ?

(h) Doped semiconductor is also called as _____ semi-conductor.

GROUP – B

2. Answer any eight of the following questions within two to three sentences each. [1½ × 8

(a) Discuss physical significance of moment of inertia.

(b) State Newton's law of gravitation.

(c) Why oil spreads over water, while water does not spread over oil surface ?

(d) How is Relaxation time related with resistance constant ?

(e) How does velocity of sound vary with temperature ?

(f) State the principle of superposition of waves.

(g) Write the mathematical form of Gauss's theorem.

(h) Under what conditions, a charged particle moving through a magnetic field experiences no force.

(i) What do you mean by time constant of an R–C circuit.

(j) How is N-type semiconductor produced ?

GROUP – C

3. Answer any eight of the following questions within 75 words each. [2 × 8

(a) State and prove theorem of perpendicular axis.

(b) Compare the gravitational potential at a point mid way between centre of earth and its surface with that on the surface.

(c) It the length of a light cantilever is doubled, how will the depression of its end change ?

(d) What do you mean by sharpness of resonance ? Under what condition is it maximum ?

(e) How are the velocities of sound at $t_1^\circ c$ and $t_2^\circ c$ are related to each other ?

(f) The efficiency of carnot cycle is $\frac{1}{4}$. By lowering the temperature of sink by 65 K, it increases to $\frac{1}{2}$. Find initial and final temperature of sink.

(g) Explain qualitatively the oscillations of electric charge in an L–C circuit.

(h) Distinguish between p-type and n-type extrinsic semiconductor.

(i) A circuit has an inductance $\frac{1}{\pi}$ H and a resistance of 2000 ohm. Find impendance offered by circuit, when 50 cycle A.C. is applied to it.

(j) Explain Lorentz force.

GROUP – D

*Answer **any four** questions within 500 words each.*

4. Obtain an expression for the moment of inertia of a solid cylinder about an axis passing through its centre and perpendicular to its length. [6

5. Derive a relation connecting Young's modulus, Bulk modulus and Poisson's ratio. [6

6. What are Damped vibrations ? Obtain general expression for displacement of a particle vibrating in a resistive medium. [6

7. Compare analytically, two SHMs having same periods, acting at right angles to each other and having phase difference of π radian. [6

8. What is Carnot engine ? Derive an expression for the efficiency of a Carnot's engine. [6

9. Show that the instantaneous currents during growth and decay in L–R circuit are complimentary to each other. [6

10. Find out expressions for efficiency and ripple factor of half wave rectifier with resistive load. [6