Total No. of printed pages = 6

3 (Sem 2) PHY M1

2015

PHYSICS

(Major)

Theory Paper : 2.1

Full Marks – 60

Time – 2½ hours

The figures in the margin indicate full marks for the questions.

GROUP–A

(Mathematical Methods–II)

Marks – 35

1. Answer the following questions : 1×5=5

(a) Evaluate $\int \vec{A} \times \frac{d^2\vec{A}}{dt^2} dt$

(b) Give a definition of $\iint_S (\vec{A}.\hat{n})\, ds$ over a surface S in terms of limit of a sum.

[Turn over

(c) Describe the co-ordinate surfaces for cylindrical co-ordinates.

(d) Evaluate $\int_0^3 x^3\delta(x-2)\,dx$

(e) Give a physical example which can be described by dirac delta function.

2. Answer the following questions : 2×3=6

(a) What are the unit vectors and scale factors in curvilinear co-ordinate system ?

(b) Prove that $x\delta(x)=0$

(c) Evaluate $\Gamma\left(-\frac{3}{2}\right)$ provided $\Gamma\left(\frac{1}{2}\right)=\sqrt{\pi}$.

3. Answer either (a) or (b) :

Either

(a) If $\phi = 2xyz^2$, $\vec{F} = xy\hat{i} - z\hat{j} + x^2\hat{k}$ and C is the curve $x=t^2$, $y=2t$, $z=t^3$, from $t=0$ to $t=1$, evaluate the line integral $\int_C \phi\, d\vec{r}$. 3

Or

(b) Determine the transformation from cylindrical to rectangular co-ordinates. 3

4. Answer either (a) or (b) :

Either

(a) Verify Gauss's divergence theorem using the function $\vec{v} = y^2\hat{i} + (2xy+z^2)\hat{j} + (2yz)\hat{k}$ and the unit cube situated at the origin. 5

Or

(b) Prove Green's theorem in the plane if C is a closed curve which has the property that any straight line parallel to the co-ordinate axes cut C in at most two points. 5

5. Answer either [(a) and (b)] or [(c) and (d)].

Either

(a) Express div $\vec{A}$ in orthogonal co-ordinates. 6

(b) Define Gamma function. Show that $\Gamma(1)=1$. 1+1=2

Or

(c) Prove that 6

$$\oint d\vec{r} \times \vec{\beta} = \iint_S (\hat{n} \times \vec{v}) \times \vec{\beta}\ ds$$

where S is the surface bounded by the closed loop and $\hat{n}$ is the unit normal vector to the plane of ds.

(d) Show that

$$\delta(kx) = \frac{1}{|k|}\,\delta(x)$$

where k is any (non-zero) constant. 2

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

Either

(a) Find a volume element dv in spherical polar co-ordinates and sketch the element giving the magnitudes of its edges. 5+3=8

Or

(b) If the temperature at any point (x, y, z) of a solid at a time t is $\upsilon(x, y, z, t)$ and if K, ρ, c are respectively the thermal conductivity, density and specific heat of the solid, assumed constant, show that

$$\frac{\partial \upsilon}{\partial t} = k\vec{\nabla}^2\upsilon, \text{ where } k = \frac{K}{\rho c}$$

and for steady state heat flow, the equation reduces to Laplace's equation. 7+1=8

GROUP – B

(Properties of Matter)

Marks – 25

Question No. 7 is compulsory and answer any *two* from the rest.

7. Answer the following questions :

(a) (i) Write down the limit of Poisson's ratio of substances.

(ii) State the different type of forces, which act on a downward spherical moving body inside a viscous medium.

(iii) State the nature of angle of contact between mercury and glass. 1×3=3

(b) A disc of 0.1m radius and mass 1 kg is suspended in a horizontal plane by a vertical wire attached to its centre. If the diameter of the wire is 1 mm and its length is 1.5m and the time period of torsional vibration of the disc is 5 sec, find the rigidity modulus of the wire. 2

8. (a) Distinguish between wave and ripple. Derive an expression for critical wavelength which determine the condition that a wave becomes ripple. 7

(b) If a number of little droplets of water, all of the same radius "r" cm, coalesce to form a single drop of radius "R" cm, show that the rise of temperature of water will be given by

$$dT = \frac{3S}{J}\left(\frac{1}{r} - \frac{1}{R}\right)$$

where S is the surface tension of water and J is the mechanical equivalent of that. 3

9. (a) Explain the rotating cylinder method of determining the co-efficient of viscosity of a liquid and give its theory. 7

(b) Calculate the mass of water flowing in 10 minutes through a tube of 0.1 cm in diameter, 40 cm long, if there is a constant pressure of 20 cm of water. The co-efficient of viscosity of water is 0.0089 c.g.s unit. 3

10. (a) Find an expression for bending moment of a horizontal beam clamped at one end and loaded at the other. 4

(b) A light beam of rectangular cross-section is clamped horizontally at one end and a heavy mass is attached at the other end. Find the depression at the loaded end. 6