18 FEB 2021

M.Sc. Semester-1 Exam
PHY-C103 {Mathematical Methods in Physics}
Paper Code - 4514

- **Attempt any 03 questions.**
- **Symbols have their usual meanings.**

Time: 01:30 Hours **Total Marks: 42**

Que:1 (a) Let $\phi(x,y,z,)$ be continuously differentiable scalar point function of q_1, q_2, q_3 than show that 7

$$grad\ \phi = \frac{\hat{q}_1}{h_1}\frac{\partial\phi}{\partial q_1} + \frac{\hat{q}_2}{h_2}\frac{\partial\phi}{\partial q_3} + \frac{\hat{q}_3}{h_3}\frac{\partial\phi}{\partial q_3}$$

(b) Derive expression of velocity and acceleration in spherical polar coordinate system 7

OR

Que:1 Show that Laplacian operator in spherical polar coordinate system can be written as and write it in cartesian, cylindrical and spherical polar coordinate system 14

$$\nabla^2 = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial}{\partial r}\right) + \frac{1}{r^2 sin\theta}\frac{\partial}{\partial\theta}\left(sin\theta\frac{\partial}{\partial\theta}\right) + \frac{1}{r^2 sin^2\theta}\frac{\partial}{\partial r}\left(\frac{\partial^2}{\partial\emptyset^2}\right)$$

Que:2 Evaluate $I = \int_0^{2\pi} \frac{\cos 3\theta}{5-4\cos\theta} d\theta$ for $|z| = 1$. 14

OR

Que:2 (a) State and derive Cauchy's theorem. 7

(b) Find the residues at all poles: 7

(i) $\frac{e^{iz}}{9z^2+4}$ (ii) $\frac{\cosh z-1}{z^7}$

Que:3 (a) Write Rodrigue's formula for Legendre polynomial and obtain Legendre's polynomial. 7

(b) Show that Bessel's function $J_n(x)$ is an even function when n is even and odd function when n is odd. 7

OR

Que:3 (a) Express $f(x) = 4x^3 + 6x^2 + 7x + 2$ and $f(x) = 4x^3 - 2x^2 - 3x + 8$ in terms of Legendre polynomials. 7

(b) Write Bessel's differential equation and solve it to obtain Bessel's polynomial. 7

Que:4 (a) Find Laplace transform of $t^2e^t\sin(4t)$ 8

(b) Find inverse Laplace transform of 6

(i) $\frac{s+1}{s^2-6s+25}$ (ii) $\frac{s+2}{s^2+4s+13}$

OR

Que:4 (a) Obtain Fourier cosine transform of 7

$$F(t) = \begin{cases} t, & 0 < t < 1 \\ 2-t, & 1 < t < 2 \\ 0 & t > 2 \end{cases}$$

(b) Find Fourier sine transform of $e^{-|x|}$ and evaluate $\int_0^\infty \frac{x\,sinmx}{1+x^2}\,dx$. 7