M.Sc. Physics Semester – 1 Examination
Phys-C-102 - {Mathematical Methods in Physics} 18 FEB 2021
Paper Code: 22924

Time: 01 Hrs 30 Min. Maximum Marks: **42**

Note: Answer **any three** questions. Figures to the right indicate marks allotted.
All symbols have their usual meaning.

Que:1 (a) Derive Rodrigues formula for Legendre's polynomial. 8
(b) Prove that $x^4 = \frac{1}{35}[8P_4(x) + 20P_2(x) + 7P_0(x)]$. 3
(c) Prove $J_{1/2}(x) = \sqrt{\left(\frac{2}{\pi x}\right)}\, sinx$. 3

OR

Que:1 (a) Write down Rodrigues formula for Hermite's polynomials and derive first 6 Hermite's polynomials at x = 3. 7
(b) Solve $\frac{\partial u}{\partial t} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$ using separation variable method. 7

Que:2 (a) Expand $f(z) = \frac{1}{(z+1)(z+3)}$ in Laurent's series valid for $1 < |z| < 3$ and $|z| > 3$. 8
(b) Find the residue at all poles: (i) $\frac{e^{iz}}{9Z^2+4}$ and (ii) $\frac{z+2}{z^2+9}$ 6

OR

Que:2 (a) State and prove Cauchy's theorem. 7
(b) Evaluate: $I = \int_0^{2\pi} \frac{d\theta}{13+5\,sin\theta}$. 7

Que:3 If $F(S)$ and $G(S)$ are Laplace transforms of functions f(t) and g(t) then prove $F(S)G(S) = \int_0^{\infty} e^{-st}(f * g)\, dt$ where, 14

$$(f * g) = \int_0^t f(u)g(t-u)du$$

OR

Que:3 If Fourier transform is defined as $\hat{f}(s) = \int_{-\infty}^{\infty} e^{-2\pi i s t} f(t)\, dt$
(a) Find Fourier transform of rectangle function $\pi(t)$ defined as 7

$$\pi(t) = \begin{cases} 1, & |t| < 1/2 \\ 0, & |t| \geq 1/2 \end{cases}$$

(b) Find Fourier transform of triangle function $\Lambda(t)$ defined as 7

$$\Lambda(t) = \begin{cases} 1 - |t|, & |t| \leq 1 \\ 0, & otherwise \end{cases}$$

Que:4 (a) Describe use of different indices in tensors. Explain quotient rule in detail. 14

OR

Que:4 (a) Explain the followings. (i) Addition and subtraction of tensors, (ii) Contraction of tensors and (iii) Spinors. 7
(b) Describe symmetric and antisymmetric tensors. 3
(c) Explain direct product of tensors. 4