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DEPARTMENT OF SCIENCES, I SEMESTER M.Sc. PHYSICS END SEMESTER EXAMINATIONS, NOVEMBER 2023 MATHEMATICAL METHODS OF PHYSICS [PHY 5151] (CHOICE BASED CREDIT SYSTEM - 2020)

Time: 3 Hours

Date: 29-11-2023

MAX. MARKS: 50

Note (i) Answer ALL questions

(ii) Draw diagrams, and write equations wherever necessary

		Marks	CO	BL
1A	Using the generating function, $g(x, t) = \frac{e^{-xt/(1-t)}}{(1-t)}$, arrive at the	5	1	3
	series form of Laguerre function, $L_n(x)$. Mention two applications of special functions in physics.			
1B	What are the advantageous of curvilinear coordinates? Using the relevant expressions for volume element in curvilinear coordinates, derive the expression for the volume element in spherical polar coordinates.	3	2	3
1C	Prove the following recurrence relation. $2xH_n(x) = H_{n+1}(x) + 2nH_{n-1}(x)$ where $H_n(x)$ are Hermite functions.	2	1	2
2A	State and prove Cauchy's residue theorem.	4	1	3
2B	Using the residue theorem evaluate, $\int_0^{2\pi} \frac{1}{5-4sin\theta} d\theta$		1	3
2C	C State Laurent's theorem (Laurent series)		1	2
3A	State and prove theorem on mean convergence of Fourier series. Arrive at conditions for Bessel's inequality & Parseval's equality.	5	3	3
3B	Using Laplace transform, explain simple harmonic motion.		3	3
3C	Develop the Fourier series expansion for the interval $[-l, l]$	2	3	2
4A	Find the eigen values and eigen vectors of the following matrix. Show that eigen vectors corresponding to distinct eigen values are orthogonal. $A = \begin{bmatrix} -2 & 5 & 4 \\ 5 & 7 & 5 \\ 4 & 5 & -2 \end{bmatrix}$	6	2	4

4B	By partial fraction, find the inverse Laplace transform of the	4	3	3
	function,			
	$g(s) = \frac{s}{(s^2 + a^2)(s^2 + b^2)}$ $a^2 \neq b^2$			
5A	Explain a permutation group. By taking three identical objects		3	3
	show that set of all transformations of these objects form a group.			
5B	Represent the following function in the form of Fourier series.		3	3
	$f(x) = x $ $-\pi < x < \pi$. Prove that $\frac{\pi^2}{8} = 1 + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{5^2}$			
	$\frac{1}{7^2}$ + Show the graphical representation of the function in $[\pi, \pi]$			
	and its periodic extension outside of $[-\pi, \pi]$			
5C	Define a group.	2	3	2