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**PHH 451**

**II Semester M.Sc. Degree Examination, September/October 2022  
(CBCS)  
PHYSICS  
Mathematical Physics – II**

Time : 3 Hours

Max. Marks : 70

**Note : Answer any four full questions, choosing one from each in Part – I to IV. Part – V is compulsory.**

**PART – I**

1. a)  $A_{\alpha}^{\beta\gamma}$  and  $B_{\delta}^{\theta}$  are two tensors. Show that their outer product is also a tensor. **5**
- b) Obtain the Christoffel symbols of II kind in plane polar coordinates. **5**
- c) Define i) contravariant and covariant vectors ii) contraction of indices in a tensor. **5**
2. a) What are Christoffel symbols of I kind ? Show Christoffel symbols of I kind do not transform like tensors. **10**
- b) Show that addition and subtraction of two tensors is also tensors of same rank. **5**

**PART – II**

3. a) Calculate the cosine Fourier transform of  $e^{-ax^2}$ , where a is a positive integer. **5**
- b) State Convolution theorem. Using Convolution theorem for Laplace transform, evaluate  $L^{-1} \left\{ \frac{s^2}{(s^2 + a^2)(s^2 + b^2)} \right\}$  with  $a \neq b$ . **10**
4. a) Solve the integral equation  $\phi(x) = x + \frac{1}{2} \int_{-1}^{+1} (t-x)\phi(t)dt$  using Neumann series method. **5**
- b) Find the series of sine and cosines of multiples of x which will represent  $x^2$  in the interval  $-\pi < x < \pi$ . Hence deduce that  $\frac{\pi^2}{6} = \sum_{n=0}^{\infty} \frac{1}{n^2} = 1 + \frac{1}{2^2} + \frac{1}{3^2} + \dots$  **10**

P.T.O.



PART – III

- 5. a) A cylinder has length 1 cm, which is measurable with a probable error of  $\pm a$  and has a radius  $r$  cm, which is measurable with a probable error  $\pm b$ . Find the area of the curved surface and determined the probable error. 8
- b) Using Trapezoidal rule, evaluate  $\int_0^1 \frac{dx}{1+x^2}$  by dividing that interval (0, 1) into 10 equal parts correct to 4 decimals. 7
- 6. a) Using Newton-Rapson method obtain the root of  $\cos x = 1 - x^2$  to three decimals. 6
- b) Obtain the best fit second-degree parabola to the following data using least square fit method. 9

<b>X</b>	1	2	3	4	5	6	7
<b>Y</b>	-5	-2	5	16	31	50	73

PART – IV

- 7. a) Explain Homomorphism and Isomorphism between the two groups with an example. 5
- b) Show that the rotations about the z-axis form a subgroup of  $SO(3)$ . Is it an invariant subgroup ? 10
- 8. a) Explain in detail the special unitary groups  $SU(2)$  and  $SU(3)$  with an example. 7
- b) Explain representation of a group with example. Distinguish between reducible and irreducible representation. 8

PART – V

- 9. Answer **any two** of the following. (5x2=10)
  - a) Explain Quotient law for the tensor and illustrate with the example.
  - b) Prove that the Sturm-Liouville operator is Hermitian over the range  $[a, b]$  and under the boundary condition.
  - c) Find the numerical solution of differential equation  $\frac{dy}{dx} = 2y^{\frac{1}{2}}$ ,  $y(0) = 1$  for  $x = 0.5$  in steps of 0.25 using Runge-Kutta method.
  - d) State and prove Schur's lemma II.

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