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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_{δ}^{θ} 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**

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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**

X	1	2	3	4	5	6	7
Y	-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. **(5×2=10)**
- a) Explain Quotient law for the tensor and illustrate with the example.
- b) Prove that the Sturn-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.