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SARDAR PATEL UNIVERSITY

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M. Sc. (Physics) 1st Semester ExaminationTuesday, 10th April, 2018

Time: 02:00 pm to 05:00 pm

Subject: PS01CPHY21 [Mathematical Physics]

Total Marks: 70

Note: (1) Figures to the right indicate marks.

(2) Symbols have their traditional meaning.

Q:1 Attempt all of the following Multiple choice type questions. [01 mark each] [08]

- (1) For a vector $|3\rangle = |1\rangle + |2\rangle$, the norm $\sqrt{\langle 3|3\rangle}$ will be equal to
- (a) $\sqrt{\langle 1|2\rangle} + \sqrt{\langle 2|1\rangle}$ (c) 3
 (b) 1 (d) $\sqrt{\langle 1|1\rangle} + \sqrt{\langle 2|2\rangle}$
- (2) All vectors $c|\psi\rangle$, $c \neq 0$, which have the same 'direction' as $|\psi\rangle$ correspond to
- (a) Hilbert space (c) the same physical state
 (b) complex conjugate (d) complete set
- (3) If $z = re^{i\theta}$ then $|dz|$ equals
- (a) $e^{i\theta}$ (c) r
 (b) 1 (d) $r d\theta$
- (4) If c is a circle $|z - z_0| = r$, $\int_c \frac{dz}{z - z_0}$ will be equal to
- (a) $2\pi i$ (c) $-2\pi i$
 (b) 0 (d) $3\pi i$
- (5) The Laplace transform is a
- (a) linear operator (c) Laplacian operator
 (b) non linear operator (d) Eigen operator
- (6) $\{\delta(t)\} = 1$ is also called
- (a) impulse function. (c) eigen function.
 (b) Laplacian function. (d) Heaviside function.
- (7) The number of different components for a symmetric tensor is
- (a) N^2 (c) $N(N+1)/2$
 (b) N (d) $N^2 - 1$
- (8) If the correspondence between elements of two groups preserves group multiplication then the two group are
- (a) commutative (c) isomorphic
 (b) abelian (d) homomorphic

(P.T.O.)

Q:2 Answer any 7 of the following 9 questions briefly. [02 marks each] [14]

- 1 Define Hilbert space.
- 2 Explain in brief basis in Hilbert space.
- 3 Define (i) simply connected region (ii) essential singularity.
- 4 Define complex number and give its geometrical representation.
- 5 Define analytic function. Write Cauchy-Riemann conditions.
- 6 Describe the RLC analogy.
- 7 Briefly explain the convolution theorem.
- 8 Explain using an example tensor algebra.
- 9 Give application of group in various branches of physics.

Q:3 (a) Define linear vector space. Explain the Cauchy-Schwarz inequality. [6]

- (b) Write notes on (i) Expansion of identity: Projection operators. [6]
(ii) Unitary operator.

OR

- (b) (i) Explain self adjointness. [6]
(ii) Show that Eigen values of a Hermitian operator are real.

Q:4 (a) Show that $\int_0^{2\pi} \frac{d\theta}{(a+b \cdot \cos \theta)} = \frac{2\pi}{(a^2 - b^2)^{1/2}}$; $a > b$. [6]

- (b) Write a note on Mapping. [6]

OR

- (b) Obtain Green's function for $\frac{d^2 y}{dx^2} + \omega^2 y = 0$ where $f(x)$ is known [6]
function and $y(0) = 0$ and $y(L) = 0$.

Q:5 (a) Find the solution of a damped oscillator described through the differential [6]
Equation $m\ddot{x}(t) + b\dot{x}(t) + kx(t) = 0$ subjected to the initial condition
 $x(0) = x_0$, $x'(0) = 0$

- (b) Explain the application of Laplace transform in the study of a step function. [6]

OR

- (b) Write a note on momentum representation. [6]

Q:6 (a) Write notes on (i) dual and irreducible tensors [6]
(ii) contraction and inner product.

(b) Write notes on (i) Christoffel symbol (ii) covariant derivative. [6]

OR

(b) Define a group. Explain its representation and character. Using a suitable [6]
example explain the group multiplication table.

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