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SEAT No.________ **No. of Printed Pages : 3**

SARDAR PATEL UNIVERSITY

M. Sc. (Physics) 1st Semester Examination
Monday, 22nd October, 2018
Time: 10:00 am to 01:00 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) $\langle \phi | \psi \rangle^* =$

(a) $\langle \psi | \phi \rangle$
(b) $\langle \psi | \phi \rangle^*$
(c) $\langle \psi^* | \phi^* \rangle$
(d) 1

(2) $\langle c | d \rangle = \alpha \langle c | a \rangle + \beta \langle c | b \rangle$

(a) is a linear function of a and b.
(b) is a linear function of α and β.
(c) is not a linear function α and β.
(d) is called a functional.

(3) In the Laurent series expansion of e^z/z^4, the coefficient b_1 i.e. the residue is

(a) 1/4 !
(b) $2\pi i$
(c) 1/2 !
(d) 1/3 !

(4) If c is a circle $|z - z_0| = r$, $\int_c \frac{dz}{(z - z_0)^2}$ will be equal to

(a) $2\pi i$
(b) 0
(c) $-2\pi i$
(d) ∞

(5) The Fourier transform of an odd function is equivalent to its

(a) sine transform
(b) Melin transform
(c) Henkel transform
(d) cosine transform

(6) The Laplace transform of t^3 is given by

(a) $s-3$
(b) $1/s^3$
(c) $6/s^4$
(d) $6/s^3$

(7) The covariant derivative of a metric tensor is equal to

(a) Dirac delta function
(b) does not exist
(c) one
(d) zero

(8) The number of generators of $S\,U(x)$ is

(a) 2^{n+1}
(b) 2^n
(c) n^2+1
(d) n^2-1

(P.T.O.)

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

1 Explain Cauchy-Schwarz inequality.
2 Show that a vector $|a\rangle$ multiplied by number 0 gives $|0\rangle$.
3 Explain essential singularity using a suitable example.
4 Show that $\oint_c \frac{dz}{(z-z_0)} = 2\pi i$.
5 Define simple pole and simply connected region.
6 Describe the RLC analogy.
7 Write the Parseval's relation and give its significance.
8 What is quotient rule.
9 Explain homomorphism and isomorphism.

Q:3 (a) Define linear vector space. Explain scalar product. [6]

(b) (i) Norm and scalar product. [6]
(ii) Explain self adjointness.

OR

(b) Two vectors in a three dimensional vector space are defined by: [6]

$$|A\rangle = \begin{pmatrix} 2 \\ -7i \\ 1 \end{pmatrix}, \quad |B\rangle = \begin{pmatrix} 1+3i \\ 4 \\ 8 \end{pmatrix}.$$

Given a=6+5i, Compute $a|A\rangle$, $a|B\rangle$, $\langle A|B\rangle$ and $\langle B|A\rangle$.

Q:4 (a) State and prove Cauchy-Riemann conditions. Evaluate $\oint_c \frac{\sin(3z)}{z+\pi/2} dz$ if c is a circle $|z| = 5$. [6]

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

OR

(b) If $f(z)$ is single valued and analytic throughout a simply connected region R, then the line integral of $f(z)$ around any closed path c which lies entirely inside R is zero i.e. $\oint_c f(z)dz = 0$. Evaluate $\oint_c \frac{z^2+4z-2}{z-4} dz$ over a contour path enclosing the pole $z_0 = 4$. [6]

Q:5 (a) Obtain the solution of a damped oscillator using Laplace transform, given by equation [6]

$mx''(t) + bx'(t) + kx(t) = 0$ with initial conditions $x(0) = x_0$, $x'(0) = 0$.

(b) Obtain the Fourier transform of a finite wave train. Using the result derive the energy-time uncertainty relation. [6]

OR

(b) Write notes on (i) convolution theorem (ii) Fourier transform of derivatives. [6]

Q:6 (a) Write notes on (i) metric tensor (ii) geodetic equation. [6]

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

OR

(b) With proper illustrations, write a detailed note on the group concept in various branches of physics. [6]

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