

CVM UNIVERSITY
M. Sc. (PHYSICS), Semester-I Examination-2021
Friday, 26th February- 2021
02:00 p.m. to 04:00 p.m.
PAPER CODE- 101510103, Mathematical Physics

Total Marks: 60

NOTE: (1) Attempt all questions.
(2) Figures to the right indicate marks.

Q-1 (A) Answer the following multiple-choice questions. [08]

- (1) Two vectors \vec{a}_1 and \vec{a}_2 are defined as linearly dependent if two numbers x_1 and x_2 can be found such that-

(A) $x_1 \neq 0, x_2 \neq 0$	(C) $x_1 = 0, x_2 \neq 0$
(B) $x_1 = 0, x_2 = 0$	(D) $x_1 \neq 0, x_2 = 0$
- (2) The Eigen values of Hermitian operator are-

(A) complex	(C) real
(B) Zero	(D) imaginary
- (3) For a complex variable z , $z + \bar{z}$ is equal to

(A) Zero	(C) Real
(B) Imaginary	(D) complex
- (4) If $z = re^{i\theta}$ then $|dz|$ equals-

(A) $r \cdot d\theta$	(C) $e^{i\theta}$
(B) 1	(D) $r \cdot dz$
- (5) The Laplace transform of 1, i.e. $L\{1\}$ is

(A) s^2	(C) $1/s$
(B) 1	(D) s
- (6) The integral transform based on the Kernel e^{iwt} is known as-

(A) Laplace transform	(C) Mellin transform
(B) Henkel transform	(D) Fourier transform
- (7) The technique for creating new, higher rank tensors is

(A) inner product	(C) Cauchy Schwartz inequality
(B) direct product	(D) Quotient rule
- (8) The tensor of rank n has Components

(A) 3^n	(C) $3n$
(B) n^3	(D) 3^{n-1}

Q-1 (B) Answer the following (Fill in the blanks and True or False). [08]

- (1) Contravariant vector is not a tensor quantity. [True/ False]
- (2) In the Laurent series expansion of e^z/z^4 , the coefficient b_{-1} , i. e. the residue is $1/2!$ [True/ False]
- (3) The Fourier transform of a real odd function is imaginary. [True/ False]
- (4) The covariant derivative of a matrix tensor is zero. [True/ False]
- (5) The eigen values of matrix $\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$ are
- (6) While mapping from z -plane to w -plane, $1/z$ corresponds to
- (7) The Laplace transform of t^3 is given by
- (8) The number of generators of $S U(x)$ is

Q-2 Attempt any six of the following. [12]

- (1) Define unitary operator and eigen value.
- (2) Define linear vector space and linear operator.
- (3) What is complex conjugate? Show that $(\bar{z}z)^{\frac{1}{2}} = |z|$.
- (4) Define analytic function. Write Cauchy- Riemann conditions.
- (5) Define Laplace transform.

P.T.O.

- (6) Draw figure and write the expression which explains the RLC analogy.
- (7) Define tensors.
- (8) Define simple pole and Laurent series.

Q-3 Define Hermitian operator and prove that its Eigen values are real quantities. Also explain the projection operators. [08]

OR

Q-3 Write a detail note on dual vectors and Cauchy-Schwarz inequality. [08]

Q-4 Using Cauchy's integral theorem show that the n^{th} order derivative of an analytic function is given as- [08]

$$f^n(z_0) = \frac{n!}{2\pi i} \oint \frac{f(z)}{(z - z_0)^{n+1}} dz$$

OR

Q-4 Find the residue of $f(z) = \frac{z^4}{(z-1)^3(z-2)(z-3)}$ at $z=1$ [08]

Q-5 Discuss how a damped harmonic oscillator can be studied with the help of Laplace transform. [08]

OR

Q-5 Explain the (I) Convolution theorem (II) Fourier transform of derivatives. [08]

Q-6 Define the Christoffel symbol of the first and second kind. Define the covariant derivatives of a contravariant and covariant tensor of rank one. [08]

OR

Q-6 Prove that $\begin{pmatrix} -xy & x^2 \\ y^2 & xy \end{pmatrix}$ is a tensor. [08]
